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Maintaining Switzerland's Top Innovation Capacity

Florence Jaumotte

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MAITAINING SWITZERLAND'S TOP INNOVATION CAPACITY

ECONOMICS DEPARTMENT WORKING PAPERS No. 487

By
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ABSTRACT/RESUME

Maintaining Switzerland's top innovation capacity

Despite some weakening in the 1990s, partly due to sluggish trend growth, the Swiss innovation performance has been very strong. There are, however, areas in which policy reforms could strengthen innovation further and help Switzerland maintain its lead in the face of a changing global environment. Boosting competition, simplifying administrative burdens and reforming the bankruptcy law would go a long way towards stimulating the innovativeness of small enterprises in sheltered services sectors, which becomes more crucial to sustaining high domestic innovation in a context where large firms are increasingly mobile. On the other hand, the growing knowledge economy and the increasing competition from emerging countries in skill-intensive activities press for further upgrading the vocational education system and increasing the efficiency of the university system. Regarding innovation-specific policies, budget spending priorities on education and research should be better protected and more resources devoted to bridge the gap between fundamental research and the market, especially through the activities of the Commission for Technology and Innovation. This Working Paper relates to the 2006 OECD *Economic Survey of Switzerland* (www.oecd.org/eco/surveys/switzerland).

JEL codes: O3, O52, I2
Keywords: Innovation, R&D, patents, Switzerland, basic research, public research organisations, business-academic links, tertiary education, scientists and engineers, product market competition, administrative burdens, bankruptcy law, double taxation, venture capital.

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Préserver le haut niveau des capacités d'innovation de la Suisse

Nonobstant une certaine détérioration durant les années 1990 liée en partie à une croissance tendencielle faible, la performance de la Suisse en matière d'innovation a été très bonne. Dans certains domaines cependant, des réformes permettraient d'encore renforcer cette performance et d'aider la Suisse à préserver sa position de leader malgré les changements qui s'opèrent dans l'environnement international. Ainsi, une intensification de la concurrence, accompagnée d'un allègement des charges administratives et d'une réforme du droit des faillites contribueraient largement à stimuler la capacité d'innovation des petites entreprises opérant dans les secteurs de services abrités, condition importante pour maintenir un niveau intérieur d'innovation élevé dans un contexte où les grandes entreprises sont de plus en plus mobiles. D'autre part, le développement de l'économie du savoir et la concurrence toujours plus grande des pays émergents dans les activités qualifiées plaident pour un renforcement du système d'éducation professionnelle et une amélioration de l'efficience du système universitaire. Concernant les politiques spécifiques d'innovation, il faudrait s'efforcer de mieux satisfaire les priorités des dépenses budgétaires en matière d'éducation et de recherche ainsi que d'accroître les ressources pour combler le fossé entre recherche fondamentale et le marché, surtout au travers des activités de la Commission pour la Technologie et l'Innovation. Ce Document de travail se rapporte à l'Étude économique de l'OCDE de la Suisse, 2006 (www.oecd.org/eco/etudes/suisse).

JEL classification : O3, O52, I2
Mots clés : Innovation, R-D, brevets, Suisse, recherche fondamentale, organismes de recherche publics, liens entre secteur privé et universités , éducation tertiaire, scientifiques et ingénieurs, concurrence sur les marchés de produits, charges administratives, droit des faillites, double taxation, capital-risque.

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Maintaining Switzerland's top innovation capacity

By
Florence Jaumotte[1]

Introduction

Switzerland enjoys a superior innovation performance by most indicators even though its position has weakened somewhat relative to other OECD countries in the 1990s. While this weakening resulted in part from a protracted economic slowdown, the paper investigates whether structural issues were also at play which might pose a more serious challenge to the Swiss innovation system in the medium- to long-term. Three main issues arise from the analysis. *First*, there are signs that innovation is lacking in small firms in sheltered sectors, which account for a relatively large fraction of the economy. In a context where large firms become more mobile, also with respect to R&D activities, a broad-based innovative capacity becomes more essential to sustain a high level of domestic innovation. *Second*, in light of the growing knowledge economy and of the increasing competition from emerging countries in skill-intensive activities, an upgrade of the educational system, currently strongly focused on vocational training, might be needed. *Third*, the strong dynamics of social public spending, if not controlled, will make it increasingly difficult to safeguard public resources which are essential to support fundamental research and the transfer of such research to the private sector.

Based on its assessment of the strengths and weaknesses of the Swiss innovation performance and underlying policies, the paper proposes options to further strengthen the country's capacity to innovate. The main policy recommendations concern both framework and innovation-specific policies. *First*, improving the conditions for entrepreneurship, especially by pursuing efforts to increase competition, reduce administrative burdens and moderate the extremely penalising character of the bankruptcy law, would go a long way towards stimulating more broad-based innovativeness in the economy. *Second*, a steadfast implementation of the planned university system reform is essential to increase its efficiency and the quality of provided education. A rise in tuition fees, accompanied by a system of loans with income-contingent repayments, should also be considered to further enhance efficiency of the system. *Finally*, a high priority needs to be given to public funding for research, including for applied research through an increase in the resources of the Commission for Technology and Innovation, which would help bridging the gap between fundamental research and the market.

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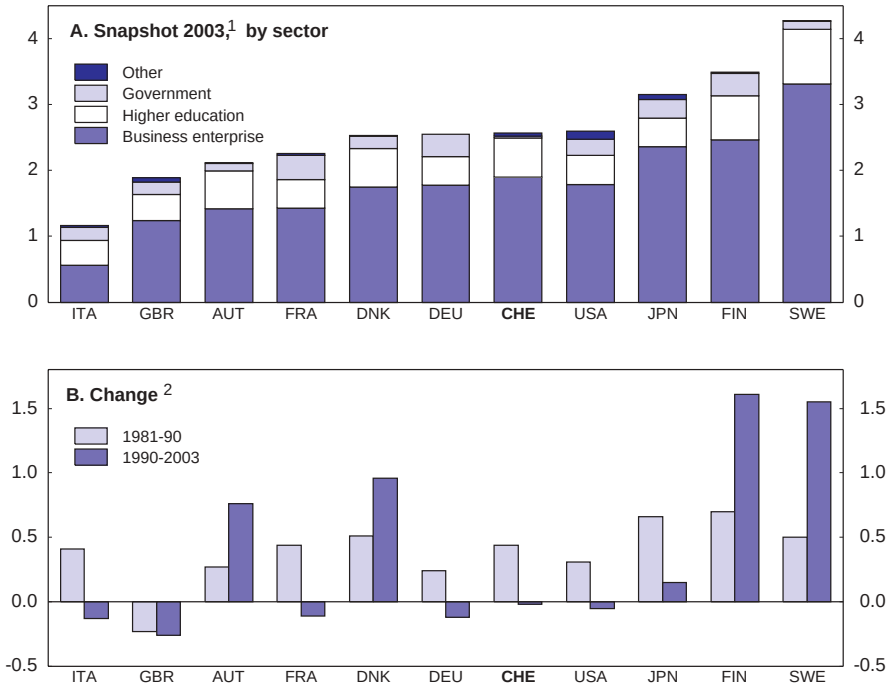
1. This paper was originally produced for the OECD Economic Survey of Switzerland published in January 2006 under the authority of the Economic and Development Review Committee. Florence Jaumotte was economist at the Switzerland/Spain Desk in the Economics Department at the time of writing. The author is indebted to Claude Giorno, Peter Hoeller, Val Koromzay, Andrew Dean, Mike Feiner, Peter Jarrett, Jean Guinet and Gernot Hutschenreiter for their valuable comments. Representatives from the Swiss ministry of the economy, various government agencies and educational institutions provided valuable insights. Special thanks go to Isabelle Duong and Desney Erb for research assistance and to Celia Rutkoski, Deirdre Claassen and Mee-Lan Frank for technical preparation.

The remainder of the paper is organised in four sections. The next section of the paper reviews in more detail the Swiss innovation performance and attempts to identify its main strengths and vulnerabilities in light of current global developments. The following section scrutinises innovation-specific policies, which relate to public R&D, business-academic links, public support for business R&D and the availability of scientists and engineers, with the aim to identify areas for improvement. Framework conditions and policies, whose primary objective is not innovation but which affect innovation in important ways, are reviewed in the next section. These range from competition and trade policy to administrative burdens, the legal system including bankruptcy law, and the financial system. The last section concludes with policy recommendations.

Strengths and vulnerabilities of the Swiss innovation system

Switzerland is amongst the top performers – and often the leading country – by most indicators of innovation. These include not only the standard indicators of research and development (R&D) intensity (Figure 1) and patent applications per million population (Figure 2), but also softer but more encompassing measures from innovation surveys (Box 1). Keeping a top innovation performance is key for the competitiveness of the Swiss economy as labour costs are high. In a recent study, Arvanitis and Staib (2002) show that Switzerland tends to specialise in quality rather than price competition, which partly explains the sizeable terms of trade gains recorded over the last decades.

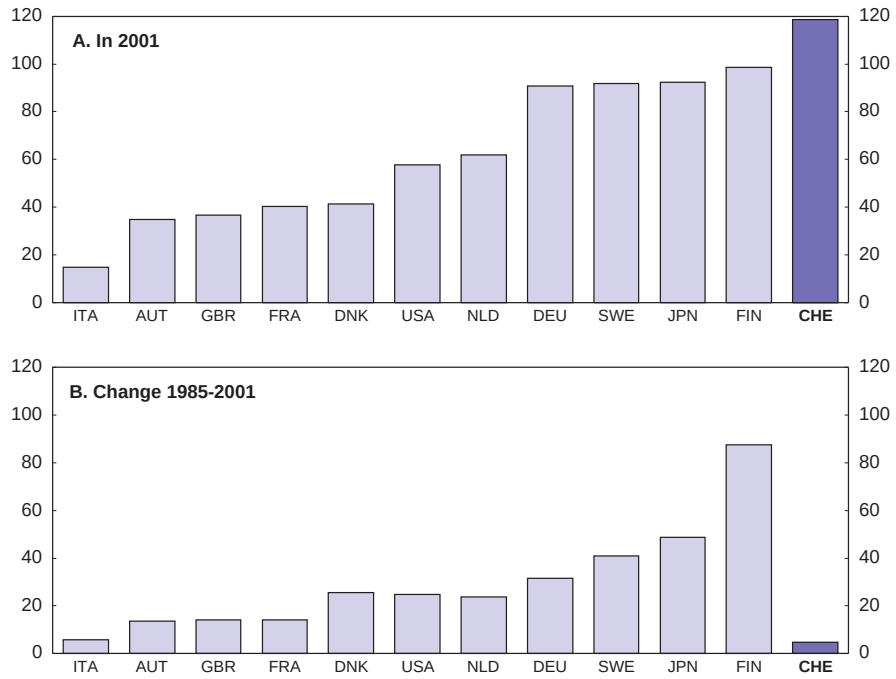
Figure 1. **R&D intensity**
Gross domestic expenditure on R&D in per cent of GDP



1. 2002 for Austria, Denmark and Italy; 2001 for Sweden and 2000 for Switzerland.
2. Or closest period where data are available.

Source: OECD (2005), *Main Science and Technology Indicators*, Vol. 1.

Figure 2. **Triadic patents**[1]
Number of applications per million population



1. According to the residence of the inventors, by priority year (the year of the first international filing of a patent). 2001 figures are estimates. Triadic patents are defined as patents filed at the European Patent Office (EPO), the US Patent and Trademark Office (USPTO) and the Japanese Patent Office (JPO).

Source: OECD (2005), *Main Science and Technology Indicators*, Vol. 1.

Despite an overall strong innovation performance, the Swiss innovation system has been showing signs of weakening over the 1990s. This is reflected in stagnation for some indicators (R&D intensity, patent applications) and an absolute decline for others such as the commercialisation of innovations (Figure 3). This is in contrast with developments in many other countries and has led to some erosion of Switzerland's lead in innovativeness, both in manufacturing and services. Although some catch-up from lagging countries is normal, it is noteworthy that Sweden and Finland have surpassed Switzerland in R&D intensity by a substantial margin and are performing better in a number of innovation-related areas (Section C).[2] Though the conditions in these two countries were specific due to a significant economic crisis, their experience shows that more can be done. Some of the weakening in Swiss innovation performance can certainly be attributed to the protracted recession of the 1990s, which constrained both private and public funding for R&D. But the rebound in economic activity in the late 1990s did not yield a marked improvement in innovation performance. Moreover, some of the slower growth turned out to be structural, implying that firms have to innovate in a lower-growth context (Box 2).

2. The relative deterioration is worse when R&D is expressed in per capita terms: while R&D per capita increased by 50% in real terms in Switzerland since the beginning of the 1980s, it multiplied by 2.5 in Sweden and 4.5 in Finland.

Box 1. **Innovation survey indicators: benchmarking Switzerland**

Technological innovation is defined in the OECD Oslo Manual as the implementation/commercialisation of a new or significantly improved product, or the implementation/adoption of a new or significantly improved production or delivery method. It can of course embody invention, but this is neither a necessary nor a sufficient condition of innovation, which can be seen as any aspect of a process ranging from initial research through the development of prototypes and the registration of inventions (*e.g.* patents) and eventual commercial application. The recent development of innovation surveys has allowed the collection of more encompassing measures of inputs into the innovation process and of registrations of inventions. This has strongly improved the coverage of innovations in services and in small firms, for which R&D spending and patenting are less relevant measures of innovation activity. Beyond R&D, innovation spending includes the acquisition of machinery, training, external knowledge, as well as testing and product design. Although the comparison is limited to EU countries for which comparable data exist, Switzerland also has the highest share of innovation spending in sales, both in manufacturing and in services (Table 1). Similarly, measures of the registration of inventions can be extended beyond patents to include trademarks, design registration, copyright and informal methods of protection. Looking for example at trademarks, Switzerland has the highest rate of applications per million population.

Table 1. **Innovation performance in the private sector**[1]

	All firms		
	Innovation-expenditure (% of sales)	Share of innovators (%)	Sales share of products new to the firm (%)
Switzerland	**3.5**	**67.6**	**23.5**
Austria	1.7	48.8	13.2
Belgium	2.7	50.1	13.9
Denmark	0.5	44.3	13.5
Finland	2.5	44.9	17.5
France	2.5	40.8	11.8
Germany	2.7	60.8	23.4
Greece	2.1	28.1	8.9
Iceland	1.7	55.0	3.2
Italy	2.0	36.3	16.1
Luxembourg	1.3	48.3	7.4
Netherlands	1.5	45.3	12.1
Norway	1.2	36.3	7.2
Portugal	2.6	46.3	15.1
Spain	1.2	32.6	17.0
Sweden	. .	46.8	. .
United Kingdom	1.8	35.8	15.1

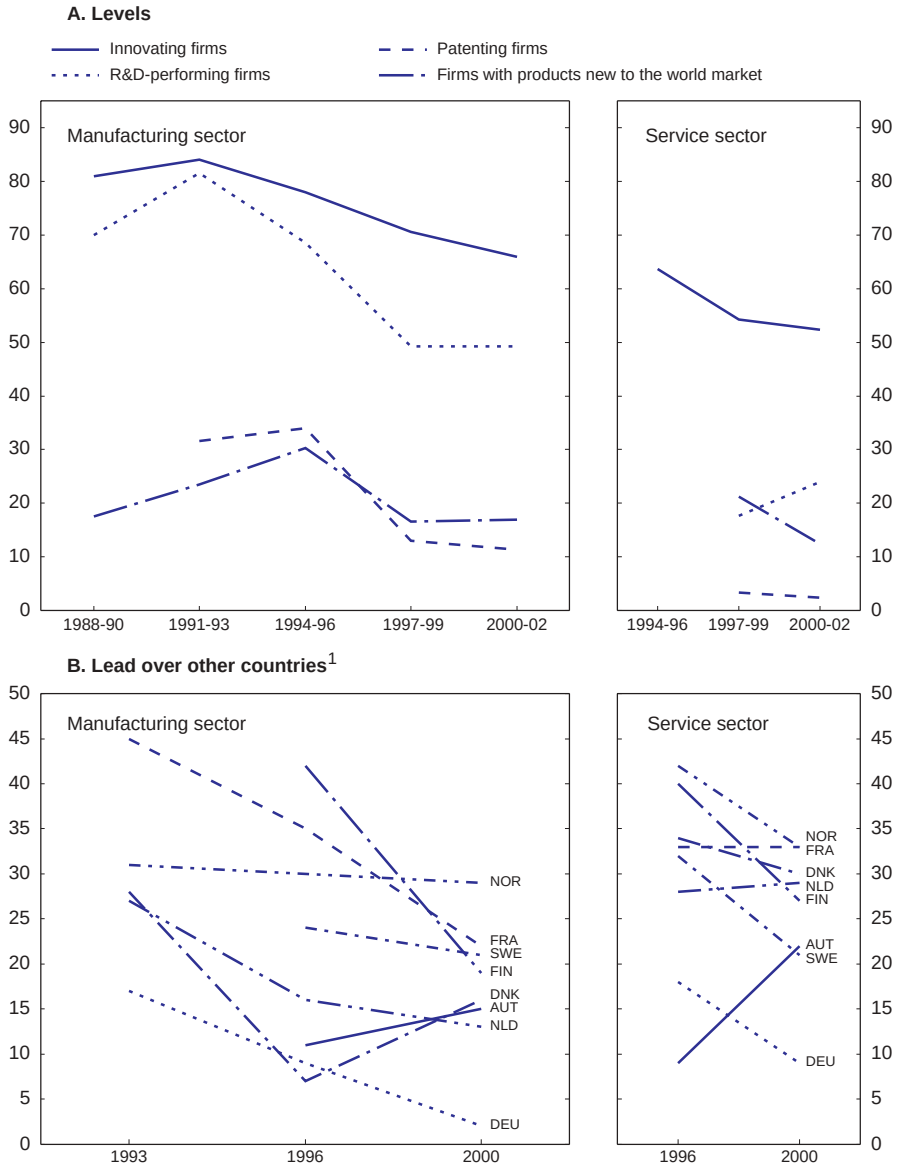
1. 2000-02 for Switzerland and 1998-2000 for all other European countries.

Source: Eurostat, NewCronos; *http://europa.eu.int/newcronos/*.

Innovation surveys also measure the implementation of innovations, *i.e.* the successful commercialisation or adoption of innovations. It is important to measure this stage, since the link between research and the marketing of products has been identified as an issue for productivity growth in several countries. Two main indicators are the proportion of firms which have introduced a new process or product, and the share of sales accounted for by new products.[2] The main drawback of these indicators is that they are "softer" as the evaluation of the novel character of the process or product is judgmental. Again, Switzerland is ahead of most EU countries with respect to these two indicators, at least as regards firms with 10 or more employees.[2]

1. Innovation includes both true innovation and imitation, since the process or product only needs to be new to the firm, and not necessarily to the market. A comparison of true innovations across countries can not be made because the Swiss definition differs from that of other countries.
2. This is only a partial view as the innovation surveys do not compare firms with less than 10 employees, which represent a large majority of firms in Switzerland. More encompassing surveys of entrepreneurship (see below) provide a less positive picture of entrepreneurship in Switzerland. The cross-country comparability of data on the share of new products in turnover can also be hampered by a number of factors, such as differing lengths of product cycles and degrees of competition.

Figure 3. **Trends in innovation activities of Swiss firms**
As a percentage of all firms



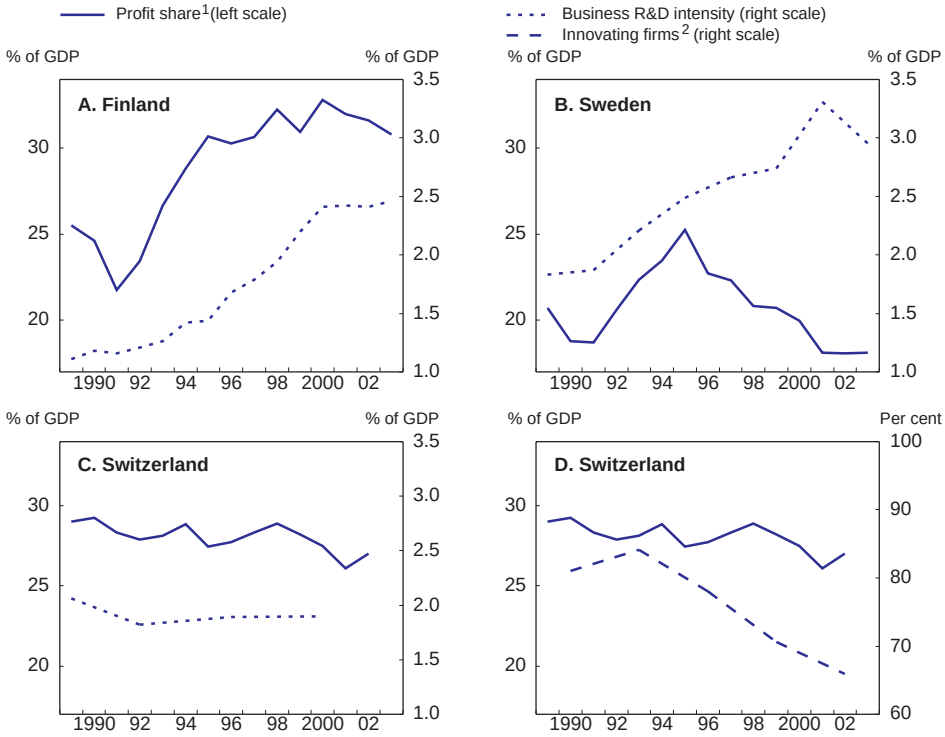
1. Difference between proportions of innovators in Switzerland and those of other countries.

Source: Swiss Innovation Survey.

Box 2. **The erosion in the Swiss R&D lead: is it cyclical or structural?**

Some believed that weakening innovativeness could be entirely explained by the protracted recession of the 1990s and that the innovation performance would rebound once the recovery became firmly established. Switzerland indeed suffered a double-dip recession in the 1990s, while other countries only had one recession. This reduced the internal funds of firms, which are the main source of financing for innovation projects (Figure 4). The recession also affected public finances, in particular those of the Confederation,* leading to a decrease in the public funding available for innovation of about 0.15% of GDP from an already average level.

Figure 4. **Profits, R&D and innovation**



1. Gross operating surplus as a share of GDP.
2. Innovating firms as a percentage of all firms, in the manufacturing sector.

Source: Swiss Innovation Survey; OECD (2005), *National Accounts* and *Main Science and Technology Indicators,* Vol. 1.

However, a comparison with Finland and Sweden suggests that the unfavourable business cycle may only be part of the story. On the one hand, the output gaps were much more negative in Finland and Sweden than in Switzerland in the 1990s. On the other hand, although there is a link between profits and R&D over certain periods, as shown for example by the parallel evolution of the profit share and the ICT sector in Finland and to a lesser extent in Sweden, the direction of causality is not clear. Some changes in the profit share may have resulted from developments in the ICT sector rather than the reverse, as was the case in Sweden around the millennium when the burst of the ICT bubble caused a strong fall in profits. Finally, the link between profits and R&D can be weakened by a series of other factors, especially the possibility to finance R&D by other means than profits.

Some of the factors behind the weakening of innovation turned out to be structural. The Swiss potential growth has slowed from 1.9% per annum over 1980-90 to 1.4% per annum over 1991-2004, mostly due to smaller gains in potential employment. Demographic trends will continue to reduce potential growth over the next decades. Moreover, the mandatory increases in social security spending tend to crowd out public funding for innovation – a high return expenditure item – in a context of budget consolidation. The weakening of innovation performance (even if partly cyclical) may itself have long-term effects by reducing potential growth and thus the resources available to finance future innovations.

* The Confederation is the main provider of funding for research. In 2002, public funding of research amounted to CHF 2 785 million, of which CHF 2 060 million were provided by the Confederation and CHF 725 million by the cantons.

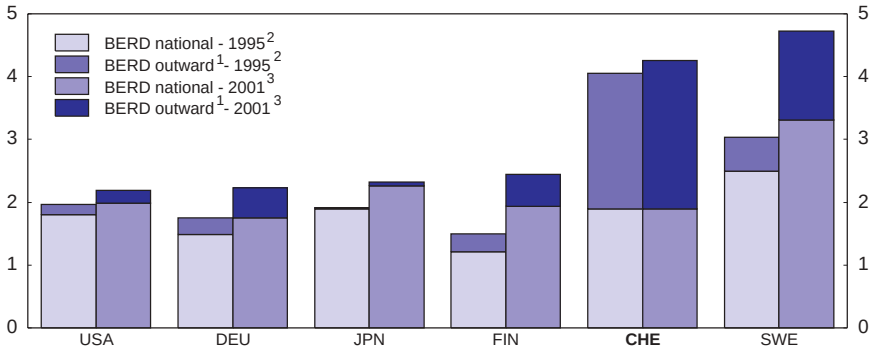
Multinationals, especially in the pharmacy/chemical sector, account for a large share of Swiss domestic R&D (Table 2). Due to the small size of Switzerland and the internationalisation of multinationals' activities, this is also reflected in large outward R&D, amounting to about 120% of domestic R&D (Figure 5). The growing globalisation of R&D represents both a challenge and an opportunity for Switzerland. If Switzerland can remain sufficiently attractive for multinationals, it could gain from new implantations of R&D centres. On the other hand, there is an inherent trend to delocalise R&D from Switzerland, due to the need for bringing research closer to larger markets and research bases (as in the US). Although there are benefits from outward R&D, in terms of repatriated profits and technology spillovers, it is also important to keep R&D on domestic soil, because these are high value-added activities which generate large tax revenues from both capital and labour, and because the location of R&D is subject to agglomeration effects.

Table 2. **Business R&D expenditure by sector**

	1996		2000		1996-2000 annual average change	1996	2000	Contribution to change in R&D intensity
	CHF million	%	CHF million	%	%	% of GDP	% of GDP	%
Machinery, metallurgy	2 180	32.2	2 910	37.7	7.5	0.58	0.70	0.12
Pharmaceuticals, chemicals	2 625	38.8	2 475	32.1	-1.5	0.70	0.60	-0.11
Research laboratories	990	14.6	1 085	14.1	2.3	0.26	0.26	0.00
Food products	360	5.3	390	5.1	2.0	0.10	0.09	0.00
Electrotechnics	310	4.6	355	4.6	3.4	0.08	0.09	0.00
Information and communication technology (ICT)	90	1.3	320	4.2	37.3	0.02	0.08	0.05
Mining, quarrying and construction	55	0.8	15	0.2	-27.7	0.01	0.00	-0.01
Other	160	2.4	160	2.1	0.0	0.04	0.04	0.00
Total	6 770	100	7 710	100	3.3	1.81	1.86	0.05

Source: OFS, Statistics on R&D.

Figure 5. **Total business expenditure on R&D**
In per cent of GDP



1. Outward R&D was estimated by applying the observed outward-to-national R&D ratio for industry (manufacturing for Japan and Sweden) to the observed business R&D in the whole economy. This may lead to overestimate outward R&D somewhat.
2. 1992 for Finland and 1996 for Switzerland.
3. 1998 for Finland and 2000 for Switzerland.

Source: OECD (2005), *Main Science and Technology Indicators,* Vol. 1 and Activities of Foreign Affiliates database.

A second challenge arises from the development of the knowledge economy and the growing competition from emerging countries in skill-intensive activities. In line with its vocational education system, Switzerland is traditionally specialised in mid-tech rather than high-tech sectors, albeit in high knowledge content niches (Figure 6). If mid-tech sectors have by definition a lower potential for innovation, more importantly, Switzerland missed the opportunity to develop a strong ICT sector in the 1990s and this largely explains the difference in performance with Finland and Sweden. High-tech R&D also tends to be performed abroad though this reflects partly the high internationalisation of the pharmaceutical industry (Table 3).[3] This pattern of specialisation is slowly changing, with dynamic high-tech sectors, such as medical instruments and chemistry, gaining ground in recent years.[4] Switzerland also holds one of the strongest positions in knowledge-intensive market services, thanks to its large financial market.[5] In part related to this, Switzerland has become the country with the highest share of ICT equipment using sectors despite having missed the opportunity to enter the ICT producing sector.

Switzerland's gap in labour productivity growth with other countries suggests that innovativeness may be low in some parts of the economy which are not well captured by traditional indicators of innovation, especially in sheltered sectors (Table 4).[6] This is confirmed by international surveys which find a low entrepreneurship of existing firms (Section D).[7] Firms are typically much smaller in Switzerland than in most other countries: close to 90% of firms count less than 10 full-time employees and account for 25% of value added. Innovation capability decreases with firm size and anecdotal evidence suggests that very small firms face major difficulties to absorb new technologies, due for example to the lack of a qualified engineer on the payroll. The innovation capabilities of SMEs may also be more sensitive to the business cycle than those of large firms, since they tend to derive a larger share of their profits from the domestic market. Finally, product market regulation remains much more stringent in Switzerland, implying that competition and incentives to innovate are low in sheltered sectors.

3. Hotz-Hart and Küchler (2005) find that the Swiss foreign patent portfolio is more high-tech than the domestic portfolio. The foreign portfolio designates the patents owned by Swiss firms for inventions made abroad, while the domestic patent portfolio refers to patents for inventions made in Switzerland irrespective of the nationality of the firm owning the patent.

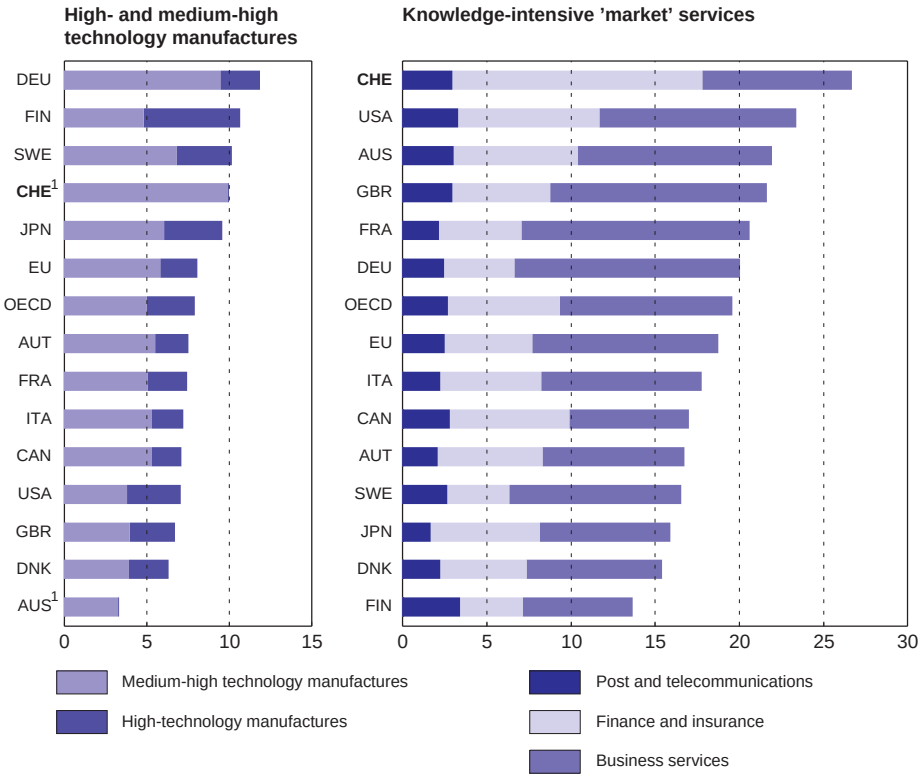
4. These developments are largely driven by SMEs which have taken the lead in the most attractive segments (Hotz-Hart and Küchler, 2005). Electrical engineering remains weak however.

5. Knowledge-intensive services include post and telecommunications, finance and insurance, and business services (excluding real estate). Other services sectors are considered to have a low potential for innovativeness. The value added share of the latter is not higher and has not grown faster in Switzerland than in other countries.

6. See OECD (2006a) for a discussion of productivity measurement issues.

7. The finding of the Global Entrepreneurship Monitoring survey is based on a survey of the adult population between the ages 18-64 and a definition of entrepreneurship which includes both innovativeness and some job growth. When the sample is limited to firms of more than 10 employees and the criterion of entrepreneurship to the introduction of innovation, as in innovation surveys, Swiss SMEs perform well relative to SMEs in other countries.

Figure 6. **Technology and knowledge-intensive industries**
Share of total gross value added, average 2000-02



1. The medium-high technology manufactures data also include the high-technology manufactures sector.

Source: OECD, *Science*, *Technology and Industry Scoreboard*, 2003 and 2005.

Table 3. **R&D spending according to technology and knowledge intensity**

	Domestic R&D		Outward R&D	Domestic R&D		Outward R&D
	1996	2000	2000	1996	2000	2000
	In CHF millions			In percentage		
Technological sector						
High-tech manufacturing	1 439	2 875	6 146	21.3	36.4	62.8
Mid-tech manufacturing	3 411	2 648	1 485	50.4	33.6	15.2
Knowledge-intensive market service activities	1 081	1 581	1 813	16.0	20.0	18.5
Other activities	840	786	341	12.4	10.0	3.5
Total	6 771	7 890	9 785	100.0	100.0	100.0

Source: OFS, Statistique de la R-D.

Table 4. **Labour productivity growth**
Average rate over the period 1992-2002[1]

	Switzerland		Austria	France, Germany and Italy	Denmark, Finland and Sweden	United States
	ESPA[2] definition	STATEM[3] definition				
TOTAL	0.6	..	1.7	1.3	2.4	1.6
Agriculture, hunting, forestry and fishing	-2.3	..	2.7	5.1	5.3	2.7
Mining and quarrying & manufacturing & electricity, gas and water supply	3.0	3.5	4.3	2.6	5.1	3.4
Mining and quarrying	..	3.6	2.9	..	5.0	2.7
Manufacturing	..	3.6	4.1	2.6	5.4	3.9
Electricity, gas and water	..	2.1	5.4	3.6	3.5	1.1
Construction	-1.3	0.3	1.9	-0.1	0.7	0.2
Wholesale and retail trade; hotels and restaurants	0.2	1.1	1.6	0.3	2.2	3.8
Wholesale and retail trade; repairs	1.0	1.9	2.1	0.9	2.5	4.0
Hotels and restaurants	-2.7	-2.1	0.1	-2.7	0.8	0.6
Transport, storage and communication	2.4	1.9	1.6	4.4	4.3	2.6
Finance, insurance, real estate and business activities	1.0	-0.1	-1.2	-0.9	0.3	0.7
Financial intermediation	4.5	-2.6	1.2	1.6	4.3	3.7
Real estate, renting and business activities	-1.0	-1.3	-2.0	-1.7	-0.6	-0.4
Community, social and personal services	-1.2	-0.4	-0.4	0.4	0.4	-0.3
Total services[4]	0.2	0.6	0.5	0.7	1.4	1.6
Business sector services[5]	1.1	1.1	0.8	0.8	1.9	2.4

1. 1992-2001 for the United States.
2. ESPA: Swiss labour force survey (Enquête suisse sur la population active).
3. STATEM: Statistics on employment (Statistique de l'emploi).
4. ISIC 50-99.
5. ISIC 50-74.
Source: OFS and OECD, STAN database.

Thus, despite an overall strong performance, there are areas in which policy reform could strengthen innovation, which is important going forward. The next two sections review the state of innovation-specific policies and framework conditions to identify areas for improvement.

Innovation-specific policies[8]: how can they be improved?

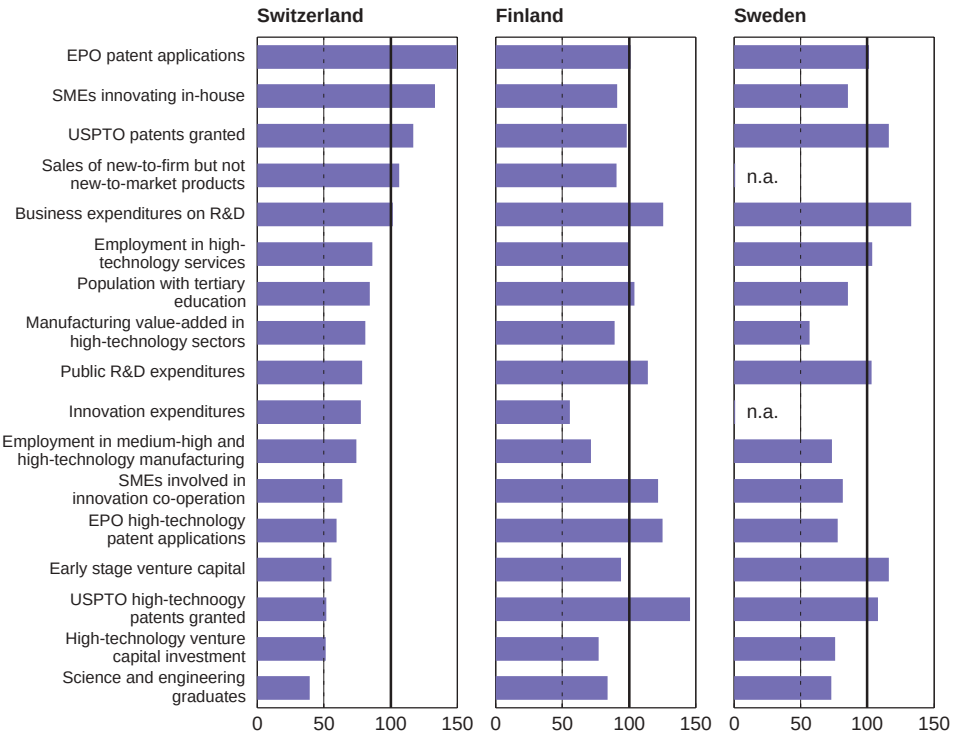
Figure 7 shows indicators of the performance of the Swiss innovation system drawn from the EU innovation scoreboard in comparison with Finland and Sweden, two countries where innovation performance has also been excellent. Switzerland ranks third on the overall innovation index,[9] after Sweden and Finland. However, the Swedish and Finnish performance is more even across indicators, and the comparison reveals a number of areas where the Swiss performance could be improved. These include the share of science and engineering graduates, the degree of specialisation in high-tech, the development of the venture capital market, the integration of SMEs in innovation co-operation and public R&D spending. This section reviews the state of innovation-specific policies ranging from public R&D to business-academic links, public support for business R&D, and the availability of scientists and engineers, while framework conditions are taken up in the next section.[10]

8. Due to a lack of available information, research and training in health is not specifically dealt with in this report, in spite of the importance of these outlays for public education and R&D budgets.

9. This index provides an overview of national innovation performances based on the aggregation of 18 indicators.

10. See also OECD (2006b) for an examination of the Swiss innovation policy with a special emphasis on the steering and funding of the innovation system and the challenges posed by the internationalisation of R&D.

Figure 7. **Strengths and weaknesses in innovation performance**[1]
Three best performers in EU25 = 100, latest available year



1. EPO: European Patent Office, USPTO: US Patent and Trademark Office, SMEs: Small and medium-sized enterprises.

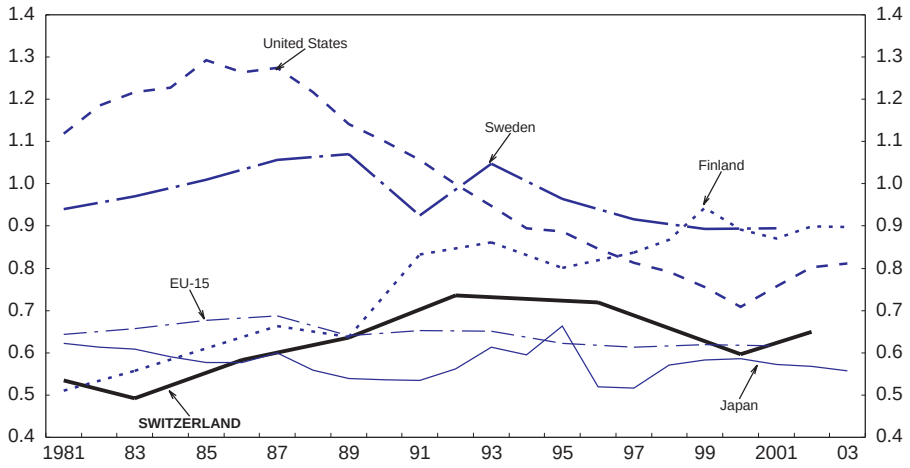
Source: European Commission, Community Research and Development Information Service (CORDIS), European Innovation Scoreboard 2004.

Public funding for research could be better prioritised

Since the beginning of the 1990s, Switzerland is faced with rapidly rising public spending, especially mandatory social outlays (OECD, 2006a), raising concerns about the availability of sufficient public funding for research in the future. Public funding for R&D is only average by international standards, at about 0.65% of GDP, and already underwent cuts in the 1990s which affected primarily public research (Figure 8).[11] In the future, fiscal consolidation coupled with mandatory increases in social security outlays will make it difficult to maintain a high growth rate of public funding for research. The predicted slowdown of trend growth will constrain resources even further. In a recent change of orientation, the government decided to prioritise spending on education, research and technology and announced an above-average 6% yearly growth of spending on these items between 2004 and 2007. However, the promised increases had to be scaled back substantially to balance the budget. There is a need to safeguard more effectively public spending priorities on research given its high social rate of return.

11. In contrast, Finland increased its public funding for innovation by 0.26 percentage point from an initial level similar to that of Switzerland in 1989. In Sweden, the level of public funding decreased by a similar 0.1 percentage point of GDP but from a much higher level. In Sweden and Finland, the very high average share of non-business R&D in GDP is estimated to raise business R&D by 25% above the OECD average, or by about 0.4% of GDP (Jaumotte and Pain, 2005b and d).

Figure 8. **Trends in public funding for R&D**
As a percentage of GDP



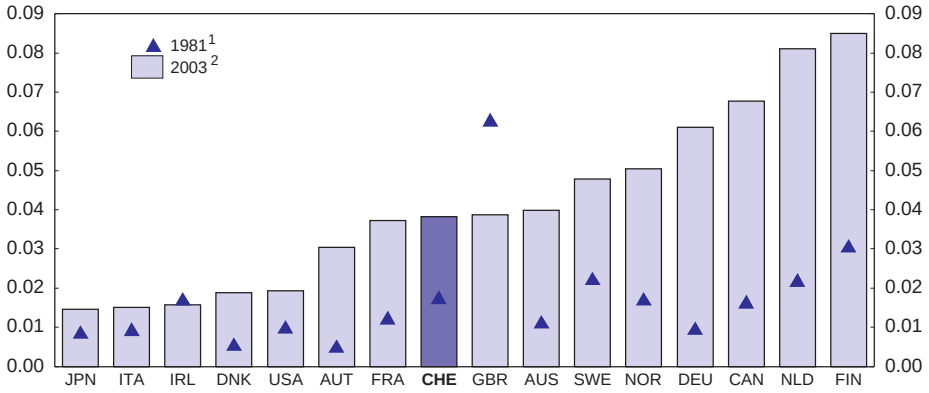
Source: OECD (2005), *Main Science and Technology Indicators*, Vol. 1.

The pooling of resources through an intensification of national and international research co-operation is increasingly advantageous in a context of rising technological complexity. Action has been taken in this area by the government: Switzerland became a full partner of the Sixth EU Framework Programme for Research and Technological Development in early 2004.[12] The public funding of EU programmes has risen from close to nothing in the early 1990s to about 8% of the public funding for research in 2002 (Lepori, 2005).

There is also scope to complement public funding by increasing private funding of university research. One source of private funding is the commercialisation of universities' inventions. In this respect, the recent development of technology transfer offices (TTO) in universities is a welcome step, and their activities should be further expanded. Secondly, there remains room to increase the direct funding of university research by businesses which did not increase as much as in some other countries following reductions in firms' in-house basic research (Figure 9).

12. Swiss partners now obtain their funding directly from the European Commission instead of the Swiss government and can undertake the role of project co-ordinators. Some EU structural measures such as Marie Curie grants have also been opened up to Swiss participants.

Figure 9. **Business funding of non-business sector R&D**
Per cent of GDP



1. 1986 for Switzerland.
2. 1996 for Italy; 2001 for Sweden; 2002 for Australia, Austria, France, Ireland, Netherlands and Switzerland.

Source: OECD (2005), *Main Science and Technology Indicators,* Vol. 1.

Public funding needs to stimulate applied research

Basic versus applied research

Most of the public funding is allocated to basic research,[13] which also benefits from a strong private involvement.[14] As a result, Switzerland performs very well on basic research (Figure 10) even though the size of public R&D is only average.[15] This is reflected in high numbers of scientific publications per million population and citation indices. Fundamental research is the basis of innovation, since fundamental scientific and technological advances create new opportunities for businesses to innovate (Jaumotte and Pain, 2005a, b, c and d; Falk, 2004a). The effects estimated in a large cross-section of OECD countries are potentially sizeable: an increase of non-business R&D by 0.06 percentage point of GDP (an average change in OECD countries)[16] raises business sector R&D by over 7% and total patenting by 4% on average. The research carried out in public research organisations (PRO) also provides training to those scientists and engineers that later work in the business sector. However, benefits may be smaller when basic research is performed by the business sector, since diffusion to the rest of the economy is limited by the protection of intellectual property rights. The very good current indicators reflect past investments. Keeping basic research a priority is important for the future and offers scientists the best chance to be successful in the international competition for funds.

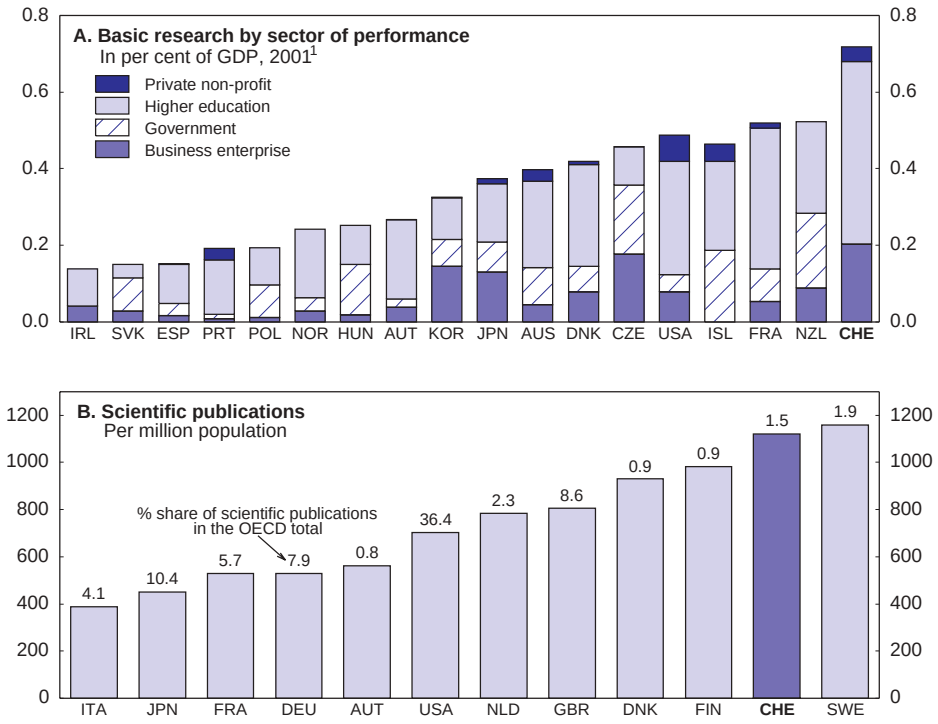
13 Public R&D is quite specialised in basic research since the public research sector consists mostly of the higher education sector, and public research institutes outside the university system are very limited.

14. The share of the business sector in publications is also about double the OECD average (11% compared to 5.5% over 1994-99).

15. The measure of basic research is not perfectly comparable across countries, because some countries (including Switzerland) include capital expenditure while others do not. The indicator is also not available for all countries (*e.g.* Germany, Finland and Sweden). However, the much higher level of basic research in Switzerland and its top performance on scientific publications suggest that the country is very strong in basic research.

16. More precisely, this is the average of within-country standard deviations over time in OECD countries. This is preferable to a cross-country standard deviation because of the scale of differences across countries and the feasible extent to which some policies may be changed.

Figure 10. **Basic research and scientific publications**



1. 2002 for Czech Republic, Hungary, Iceland, Slovak Republic and United States; 2000 for Australia, Ireland and Switzerland; 1998 for Austria.

Source: US National Science Foundation, *Science and Engineering Indicators 2004* and OECD, RDS database, May 2005.

It is also crucial to bridge the gap between basic research and the market. The distribution of general university funding, part of which is used for research, is supporting more the highly performing poly-technical institutes (EPF). On the other hand, research is less well funded and resources are not well deployed in the universities of applied sciences as well as in the cantonal universities,[17] which are strong in the fields of human and social sciences. The plan to reform university financing, currently under discussion, would rebalance the general funding of institutions of higher education by introducing a standard subsidy per student and field but is facing strong opposition from interest groups. This initiative is complemented by the recent creation of new research poles, which give universities incentives to pool their research resources together and reap the benefits from larger scale.

Linkages between universities and businesses are also important to strengthen technology transfers and the implementation of innovations (Jaumotte and Pain, 2005a, b, c and d).[18] The diffusion of technology operates through different channels such as the simple exchange of information, the licensing of protected inventions, research cooperation agreements, the mobility of personnel and the creation of

17. The funding of the latter appears to have been insufficient in the face of the large increases in enrolment in human and social sciences, forcing the staff to spend most of their time on teaching.

18. Jaumotte and Pain (2005b and d) use the share of non-business R&D expenditure financed by industry as a (partial) indicator of the extent of research collaboration between business and public research organisations. They find that an increase of 1.4 percentage points of this share (the average of within-country standard deviations of OECD countries) will eventually raise business sector R&D by over 8% and total patenting by close to 2½ per cent.

spin-offs and start-ups.[19] Co-operation agreements with existing businesses are more far-reaching than spin-offs and start-ups, which tend to remain small relative to the size of the economy (Marmet, 2004). Part of the public funding for research is allocated to support business-university research co-operation but resources remain limited, at about 3% of the total public funding for research (Lepori, 2005).[20] The funding is allocated through the CTI and is given to the academic partner of the research co-operation while the business partner has to cover at least half of the project costs. Evaluations of similar programmes have shown that such support does lead to a more intensive adoption of technologies, especially for firms which do not use them at the start of the programme (Arvanitis *et al*., 2002).[21] Recent increases in the rejection rate of applications due to limited resources suggest that an increase in the budget of the CTI would be easily absorbed.

SMEs are significantly under-represented in business-university co-operation (Arvanitis and Hollenstein, 2002a), as well as in co-operation agreements in general (Figure 7).[22] Small businesses need more and more to have a well-trained engineer on the payroll in order to improve their absorptive capacity. Recent initiatives to address constraints specific to SMEs are welcome and should be further developed. For example, the CTI tries to develop "pull" services (from businesses to universities) to complement the existing "push" services (from universities to businesses) by encouraging businesses and public research organisations (PROs) to form consortia for the exchange of information. In the longer run, an increase in the supply of university graduates, including in engineering, should increase the pool of qualified personnel available to smaller firms.

Another obstacle to the transfer of technology from universities to the market is the lack of business training of scientists and engineers who want to create spin-offs. In recent years, there has been an explosion of executive master programmes, mostly attended by people with a science or engineering background. CTI also offers education and coaching services for people interested in a business project through its "Venturelab" and "Start-up" initiatives. However, more needs to be done, particularly in the area of coaching services.[23] Recent initiatives to relax nationality restrictions for members of the boards of companies and ease immigration restrictions for foreign graduates from the Swiss university system should also be pursued, as anecdotal evidence suggests that they tend to be more entrepreneurial.

19. R&D cooperation agreements are the most frequently used channel of technology transfer between universities and businesses in Switzerland. Patenting of inventions is likely to slow down and restrict the diffusion of knowledge from universities relative to a system in which knowledge is presented at conferences.

20. Country studies indicated that in Austria public-private partnerships account for approximately 2.8% of the total science and technology budget versus 6.3% in the Netherlands and 9.1% in Australia (OECD, 2006c).

21. This study examines the effects of a former Swiss public support programme aimed at stimulating the diffusion of basic technologies (Advanced Manufacturing Technologies), controlling for selection bias.

22. The data for Switzerland are not perfectly comparable, because they cover R&D cooperation instead of the broader concept of innovation cooperation used for other European countries. Switzerland performs better when the number of firms engaged in R&D cooperation is scaled by the number of firms performing R&D activities instead of all innovative firms.

23. Swiss experts interviewed for the Global Entrepreneurship Monitor Report give a neutral to positive evaluation of business training at the post-secondary level, but suggest raising supply of coaching services for business projects.

Table 5. **Activities of technology transfer offices in selected OECD countries**
2002, in percentage of all responses

	Investigation of patenting possibility	Patent applications	Licences (out)	Licences (in)	Research agreements
Denmark	58	79	74	16	68
Germany	80	90	87	33	80
Italy (Universities)	50	82	61	18	57
Italy (Public research institutions)	60	100	80	20	80
Japan	94	94	76	71	88
Korea	50	88	75	50	63
Netherlands (Universities)	100	100	100	62	100
Netherlands (Public research institutions)	78	100	78	33	78
Switzerland (Universities)	49	57	57	26	80
Switzerland (Public research institutions)	67	78	67	22	78

Source: Arvanitis and Wörter (2005), "The Swiss Innovation System: Governance, Public Policy, Performance and Assessment of Strengths and Weaknesses", Background Report to the OECD Country Review of Switzerland's Innovation Policy on behalf of the Swiss Innovation Promotion Agency (KTI), KOF, Swiss Federal Institute of Technology, Zurich.

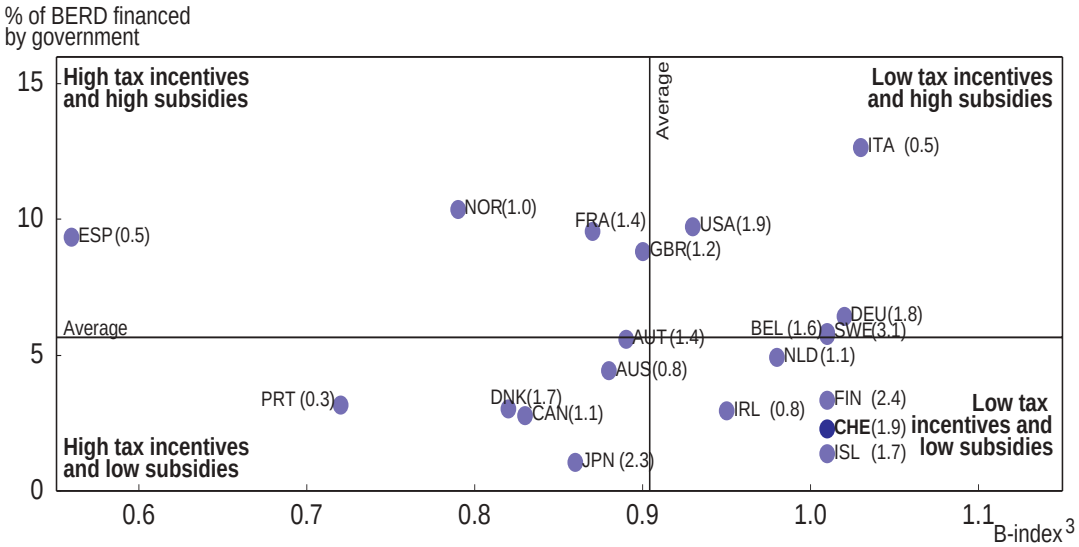
Finally, technology transfers between universities and businesses have been strengthened by the creation of TTOs in universities. However, these are still at an early stage of development (Table 5). The fragmentation and lack of co-ordination of TTOs keep search costs high for businesses, especially the smallest ones, and efforts at consolidating the system encounter resistance from universities. The functioning of TTOs also suffers from a lack of trained personnel and "cultural" conflicts between scientists and business people (Volery *et al.*, 2004). The CTI Wissens- und Technologietransfer (WTT) initiative addresses this issue as it intends to reduce fragmentation by organising existing TTOs into larger network entities.

Public support for business R&D

Although some public funding is deemed justified to internalise network externalities, there is a tradition of not providing public funding to private research activities in Switzerland, whether in the form of direct funding or tax incentives for R&D (Figure 11).[24] This decision seems warranted given that Switzerland already has one of the highest business R&D intensities in the world. Public support for business R&D is often justified by the existence of positive spill-overs for the rest of the economy, which are not taken into account in private spending decisions. However, the high level of business R&D in

24. There are only two exceptions: funding through the European Union framework programmes, where Switzerland adopted the EU rules, and direct contracts from the public administration.

Figure 11. **The state of tax and subsidisation policies for business R&D**[1]
Average per annum, 2000-03[2]



1. The numbers in parentheses are the average business R&D intensities in 2000-03.
2. Or closest period where data are available.
3. The B-index is defined as one minus the rate of tax subsidy for 1 USD of R&D by large firms in 2004.

Source: OECD (2005), *Main Science and Technology Indicators,* Vol. 1 and *Science, Technology and Industry Scoreboard*.

Switzerland increases the risk that public funding substitutes for private funding without raising total R&D spending much.[25] The existing evidence on the effectiveness of public support for business R&D also yields a mixed picture, perhaps unsurprisingly given the difficulties related to its evaluation.[26]

The case for support targeted at small firms is an open issue because scale matters for research capacity. On the other hand, deadweight losses should be much lower for small and young firms which are more constrained by capital market imperfections, including in Switzerland (Arvanitis and Hollenstein, 2002a).[27] Indeed, the cost of external funds for innovation projects is usually high, because of high risks and a substantial degree of information asymmetry, and small and young firms, which have a higher risk of bankruptcy, less collateral, and/or minimal track record, are especially affected. Young firms also have less internal funds to substitute for external financing and venture capitalists may not be interested in small firms because of the relatively high transaction costs and low growth potential. In light of the limited public resources, providing direct support for SMEs would have to be examined carefully to make sure that it would be an effective means to remedy the above noted externalities. There is evidence

25. Raising public funding to finance the subsidies or tax rebates may also create distortions in the rest of the economy.

26. It is difficult to evaluate whether the research would have been successful or even undertaken without the public support, and to estimate the effective additional resources provided by the public sector. Although the effects of public support on business R&D are generally positive, they are of a relatively small magnitude compared to those of other policies (*e.g.* Jaumotte and Pain, 2005a, 2005b, 2005c and 2005d).

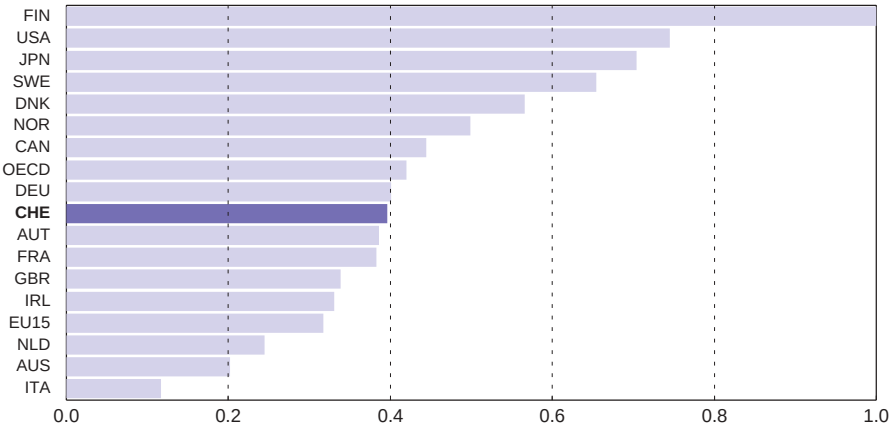
27. Such impediments concern access to bank loans for firms with less than 500 employees, internal funds (less than 100 employees), and equity funding including venture capital (less than 50 employees). The authors could not identify an impact of firm age on the financial impediments encountered by the firm, which they attribute to the high skewness of the firms' distribution towards older firms. The authors control for the firm's performance.

that the innovative capabilities of firms can be enhanced through network relations drawing on public infrastructure, partnerships between firms and research centres and clusters. Thus, government assistance to SMEs might focus on strengthening such networks, drawing on international best practice. However, the improvement of framework conditions for entrepreneurship is a precondition for targeted policies to be effective.

Efforts to strengthen higher education should be pursued

Human capital is an essential input into the innovation process. About 50% of R&D spending consists of the wage costs of R&D personnel, which includes researchers, technicians and support staff. Researchers are also a key determinant of the capacity of a country to absorb inventions made in other countries (Jaumotte and Pain, 2005b and d). Although Switzerland has a very high share of R&D personnel in total employment, its share of researchers in total employment is only average in international comparison (Figure 12). This reflects to some extent a low domestic supply of science and engineering (S&E) university graduates (Figure 7). Moreover, people trained in science and engineering are attracted by higher wages in the knowledge-intensive market services sector, where Switzerland holds a top position. On the other hand, the relative openness of the Swiss system and its attractive employment conditions enable the country to attract foreign scientists and engineers, who account for 33% of researchers.[28] The scarcity of domestic scientists and engineers may also motivate the expansion of outward R&D by domestic firms in some sectors, especially in machinery and electronics, where the availability of R&D personnel is reported as an important motive for moving R&D outside Switzerland, together with the market size and knowledge motive (Table 6). Outward R&D is typically more high-tech than domestic R&D, though this may reflect to some extent the high internationalisation of the pharmaceutical industry.

Figure 12. **Researchers in the business enterprise sector**
In per cent of total employment, 2003[1]



1. 2000 for Switzerland, United States and OECD; 2002 for Australia, Austria, Canada, Denmark, France, Italy and EU15.

Source: OECD (2005), *Main Science and Technology Indicators,* Vol. 1.

28. Foreign R&D personnel is also more qualified on average than their Swiss counterparts.

Table 6. **Motives for R&D activities outside Switzerland**[1]
Percentage of firms reporting a motive as important or very important, 2002

Panel A. By sector

Motives	Manufacturing			Services			Total
	Total	High tech	Low tech	Total	Modern services	Other services	
Market motive	43.1	45.7	36.8	23.1	30.8	16.7	39.7
Knowledge motive	28.5	26.8	32.5	30.8	35.9	25.0	28.8
Cost motive	20.4	20.2	21.1	11.6	15.4	8.3	18.9
Availability of R&D personnel	37.7	40.2	31.6	38.5	30.8	41.7	37.8

Panel B. By group of manufacturing industries

Motives	Chemicals, plastics	Machinery, vehicles	Electrical machinery, electronics	Metal	Other industries
Market motive	54.2	34.2	55.6	35.7	37.5
Knowledge motive	36.1	25.2	21.0	35.7	30.5
Cost motive	20.9	18.3	22.2	25.0	18.8
Availability of R&D personnel	16.7	46.3	51.9	21.4	37.5

Panel C. By firm size

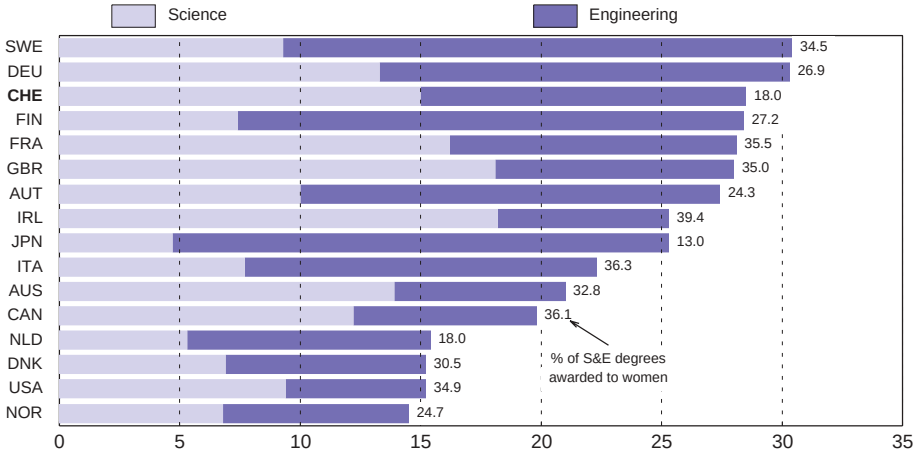
Motives	Firm size[2]			Total
	Small	Middle	Large	
Market motive	29.5	39.7	61.3	39.7
Knowledge motive	31.7	23.8	32.3	28.8
Cost motive	24.6	18.3	8.1	18.9
Availability of R&D personnel	39.3	36.5	35.5	37.8

1. The market motive refers to support of production/marketing in foreign markets.
   The knowledge motive is the average of three single motives, namely nearness to prominent foreign research universities, nearness to networks of innovative firms and knowledge transfer to Switzerland.
   The cost motive is the average of two single motives, namely lower R&D costs and stronger R&D public promotion.
2. Small designates firms with up to 50 employees; middle, firms with 50 to 250 employees; and large, firms with 250 employees and more.

Source: KOF Internationalisation Survey, 1998.

The low share of S&E university graduates results from a low level of participation in university education overall and not from a low share of S&E in total university degrees (Figure 13).[29] Switzerland has one of the lowest shares of people with tertiary education in international comparison (Figure 14). The gap with other countries appears even larger for tertiary non-university education, but cross-country differences in the classification of fields between types of tertiary education make comparisons difficult. Comparing the educational attainment of younger cohorts (25-34 years) with that of older cohorts (45-54 years), the rise in the share of people with tertiary (and university) education also appears modest in international comparison. The main improvement appears to be a small reduction in the share of people who have low educational attainment. An important feature of the Swiss education system, which partly explains the low participation in tertiary and university education, is its vocational character. Although there is a general branch, three quarters of upper secondary school graduates receive vocational instruction, which focuses on early entrance in the labour market through a system of apprenticeships. Until recently, there was no or little possibility for students in vocational training to pursue university education and the percentage of people with vocational education who graduated from tertiary (non-university) studies was only about 25%.

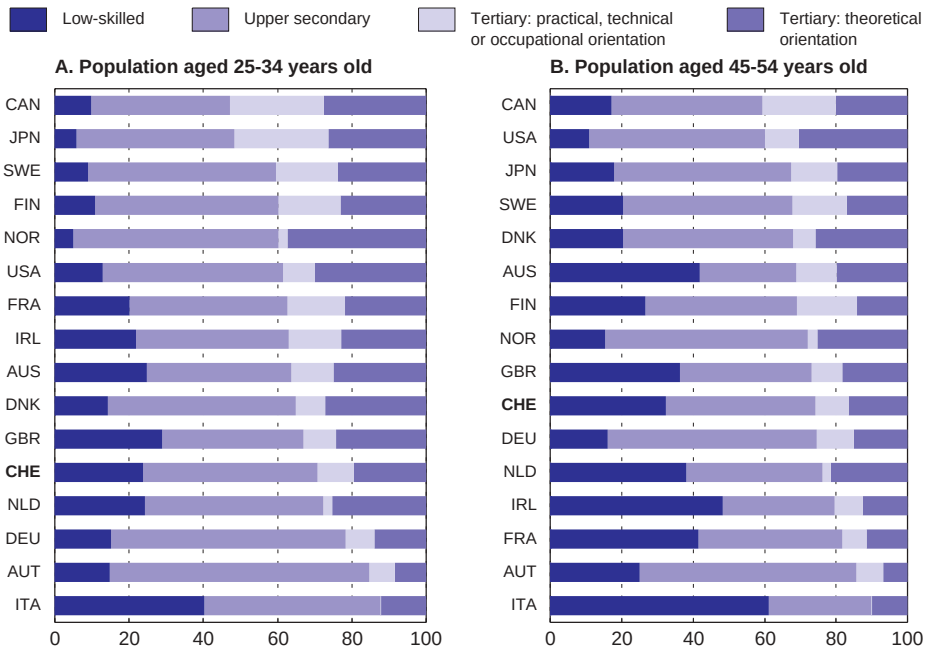
Figure 13. **Science and engineering university degrees**
As a percentage of total new university degrees, 2002[1]



1. 2000 for Canada; 2001 for Norway, Switzerland, United Kingdom and United States.
Source: Calculations based on OECD, Education database, July 2005.

29. The number of Swiss university graduates may be somewhat underestimated because some fields are classified as part of non-university tertiary education, while they are considered as part of university education in some other countries. However, looking at the total of tertiary education, Switzerland also has one of the lowest shares of people with tertiary education in international comparison.

Figure 14. **Educational attainment of the adult population**[1, 2]
2003[3]



1. "Low-skilled" comprises persons having primary school, lower secondary school or ISCED 3C short programmes as their only formal qualification. Upper secondary includes post-secondary non-tertiary programmes.
2. Countries are ordered by share of population with tertiary education.
3. 2002 for Italy and the Netherlands.

Source: OECD (2005), *Education at a Glance,* Tables A1.2a and A1.3a.

The vocational education system is considered as very successful in Switzerland, and there is a strong attachment to it. It responds well to labour market needs, as reflected in the very low unemployment rate. It is also quite integrative as illustrated by the fact that the share of people with no education is very low in international comparison. It is feared that a system that provides mainly general education may lead to over-education. However, there is a growing recognition that knowledge, as opposed merely to skills, has become more important to remain competitive in today's innovation society. A better-educated population may be generally more innovative and better able to adapt to technological change. The need to strengthen the country's knowledge base is also reinforced by the increasing competition from emerging countries in skill-intensive activities. Although there is a possibility to recruit highly qualified people from abroad, and Switzerland is very good at it, ultimately factor endowments will determine the position of the economy in the international division of labour. There are different ways in which education can be reinforced, by strengthening formal training or lifelong learning, and a combination of both is probably desirable.

In the area of formal training, the government is working towards upgrading the vocational training system, in which most students are currently enrolled, and increasing the attractiveness of general university education. The choice of upgrading vocational education instead of shifting students to general education has also been adopted in other countries with similar dual education systems (*e.g.* Germany and Austria). A number of reforms have been or are in the process of being implemented. *First*, starting in 1995, the authorities have been upgrading a number of advanced training schools into universities of applied sciences (UAS), thereby making it easier for students enrolled in vocational training to pursue university education. *Second*, secondary school vocational training has been reinforced by increasing its

formal educational component, lengthening for example the number of days spent in school at the expense of the time spent in apprenticeships, particularly in the early stage of the programmes.[30] The introduction of a vocational diploma in 1993 reflected the commitment of the authorities to improve the overall conditions of vocational training and enabled students to take up study at the UAS. *Third*, a number of vertical and horizontal possibilities for transfer have been created between vocational and general education, both at the secondary and tertiary levels. *Finally*, the authorities have fostered the mobility of students by adhering to the Bologna process and concluding agreements with those neighbouring countries that have a similar dual education system.

Although the enrolment rates in general universities (as opposed to UAS) have increased during the last two decades, a number of structural problems reduce their attractiveness. Private rates of return to such education are low relative to other types of post-secondary education (Wolter and Weber, 1999; Weber, 2003).[31] There is a high degree of fragmentation of the cantonal universities, the main provider of general university education with the poly-technical institutes (EPF). The small size of departments implies a limited supply of courses each year, which contributes to lengthening the time needed to complete the curriculum. The average length of study to obtain a diploma is six years, despite a theoretical length of 4 to 5 years (OECD, 2003b). The sometimes extreme fragmentation of the education system also limits the quality of education, which can fluctuate widely across institutions and cantons.

A number of steps are being taken to overcome these obstacles. *First*, the adhesion to the Bologna process and implementation of the separation between bachelor and master programmes will increase flexibility by reducing the minimum length of study. *Second*, the authorities are attempting to reduce the fragmentation of universities by reallocating study fields among them and favouring specialisation and profile-building of institutions, not without resistance from them. These consolidation efforts are also supported by the recent creation of six national research centres, as part of a rebalancing of project funding towards the fields of human and social sciences.[32] *Third*, there are initiatives to further improve quality assessment, which is seen as an indispensable condition for healthy competition between the institutions of higher education. *Fourth*, the authorities are restructuring the financing of institutions towards the application of a standard subsidy per student in each field. This should lead to a better use of resources, since costs now fluctuate widely across universities. It will also help overcome under-funding in cantonal universities due, among other things, to the strong increase in enrolment in human and social sciences. A new law is expected to be implemented but only by 2011.

The evaluation of the reforms undertaken so far in the area of vocational education is globally positive. Despite their recent creation, about 5% of the population in the relevant age category obtained a degree from one of the UAS, against 10% from a general university. The take-up rate of bridges between vocational and general education is, on the other hand, relatively limited. It may be asked whether the current reforms will be sufficient to maintain Switzerland's leadership in the growing knowledge economy. There may be a case to strengthen and accelerate efforts along the current lines of reform, by further strengthening vocational curricula and continued reform within and among Universities of Applied

30. This is especially important in fields such as computer sciences, where students cannot be operational before undergoing substantial formal training.

31. This may partly be attributed to a redistributive tax system which lowers income differences between people with different educational backgrounds.

32. Earlier there were fourteen centres for hard sciences and none for human and social sciences. Research topics for the new centres range from mental health (due to an increasing level of stress), to globalisation and the growing importance of media. Research on mental health (one of the poles of research) could for example help solve the fast growing invalidity insurance problem in Switzerland.

Box 3. **Funding of tertiary education in OECD countries***

In a context of growing constraints on public finances, tuition fees have been raised considerably in some countries to increase spending on tertiary education. Tuition fees are also justified from an economic and equity point of view, since individuals endowed with tertiary education draw large personal benefits from it, making it unfair to use general public funding. A number of OECD countries (Korea, the United States, Japan, New Zealand, Canada and Australia) charge significant tuition fees complemented by loans and/or grants for students from low-income families, with no evidence of adverse participation or equity effects (Blöndal *et al*., 2002). Several of these countries (*e.g*. Australia, New Zealand and the United Kingdom) also make the repayment of the student loans contingent on post-graduation income, thereby providing insurance against students' inability to repay. In the United States, where the repayment is not income-contingent, the default rate is high.

Although the arguments for providing loans with income-contingent repayments are strong, the case for providing *a priori* grants or below-market interest rates on loans appears much weaker: although some students may be poor today, they may be more affluent over their lifetime than the average tax payer. The money may be better spent on early childhood and compulsory schooling, which are the main determinants of equity in educational attainment (Carneiro and Heckman, 2003). In New Zealand, the introduction of student loans in 1992 has spurred participation in tertiary education with a significant rise in the share of students from non-traditional ethnic and socio-economic backgrounds. Key reasons were that loans were available for any approved tertiary institution and the reform of public funding for tertiary education institutions towards an equal per-student funding for public and private institutions. This led to an explosion of new providers which better reached those students (OECD, 2002). Equity could also be improved by rewarding universities for attracting students from non-traditional backgrounds.

Some countries vary fees across subjects and/or universities. Fees are typically lower in arts, higher in medicine with science and law courses falling in between, in line with the actual costs of these courses and earnings that can be expected after graduation.

* See OECD (2004a) for further details.

Sciences. Moreover, it would be efficient and equitable to raise tuition fees for tertiary education while introducing a system of loans with income-contingent repayments (Box 3). Higher tuition fees would make demand (students) attentive to the quality and subjects being supplied, with subsequent effects on the supply. Moreover the additional resources would allow the quality of staff and research to be raised. However, higher fees should not lead to lower public funding of universities. Tuition fees per student remain very low in Switzerland at about CHF 1 000-1 300, compared to the United Kingdom (CHF 6 600), Canada (CHF 9 200), Australia (CHF 15 200) and the United States (CHF 16 000-26 000).[33]

Following important progress, women accounted for 45% of those enrolled in tertiary education in the 2003-04 school year. While they have roughly reached parity for general university enrolment, their proportion in the universities of applied sciences (UAS) was only 39%, due in part to their low representation in technical fields, which account for a substantial share of all students in the UAS.[34] Although the under-representation of women in S&E is a problem in every country, it is particularly acute in Switzerland, with only 18% of university degrees in these fields awarded to women (Figure 13). Reducing this imbalance may require specific policy actions to stimulate interest of girls in the sciences from an early age, for example through the organisation of science days and science fairs (OECD, 2004b). Yet, it is not just a question of encouraging women to study sciences. Higher education institutions could also do more to recruit and retain women in research. Women only accounted for 10% of professors in

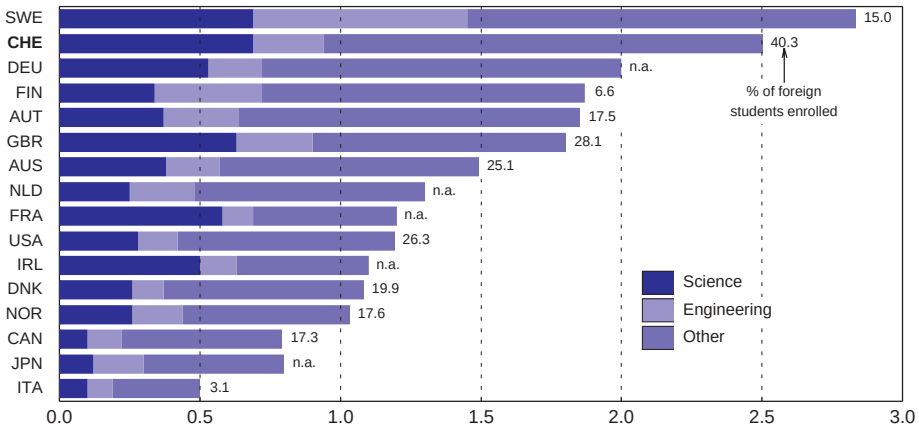
33. These figures are taken from "Pourquoi ne pas payer plus cher?", in Le Temps (21 January, 2004). Although there is no internationally comparable database on tuition fees, this anecdotical evidence suggests that tuition fees remain very low in Switzerland compared to some other countries.

34. Some courses of study, which can only be pursued part-time, are quite long and conflict with lifecycle issues for women.

general universities and 28% in UAS in 2003.[35] The authorities have taken steps in this direction by introducing a gender equity programme which includes mentoring and work-family reconciliation measures. Such measures have been shown to be important for encouraging women to pursue research careers in the public and private sectors. More generally, adopting work-family reconciliation policies would help stimulate women's investment in tertiary education, by increasing the rate of return of such education.

The Swiss university system attracts a large number of foreign students, particularly in postgraduate studies (Figure 15). With 17% of foreign students in tertiary education, Switzerland ranks second, after Australia (Office Fédéral de la Statistique, 2005).[36] These students have a higher tendency to study exact, natural and technical sciences than Swiss students: 46% of foreign students who obtained a (general) university degree in 2003 were registered in these fields, against only 27% of Swiss students. These students, whose education is mostly funded by Switzerland, constitute a pool of highly qualified people that could contribute to increase the level of education of the labour force. The easing of immigration restrictions for EU nationals will contribute to retaining more of them and more time should be given to students from non-EU countries graduating from the Swiss university system to find a job in Switzerland.

Figure 15. **Graduation rates at PhD level**
In per cent of population at typical graduation age, 2003[1]



1. 2000 for Canada; 2002 for Denmark, Finland, Italy and 2001 for foreign students enrolled in the United States.
Source: Calculations based on OECD, Education database, September 2005.

Finally, continuing education plays a crucial role in a context where knowledge evolves rapidly. Switzerland is roughly average in terms of continuing education (OECD, 2003b).[37] As in most OECD

35. Their representation could spontaneously improve due to the higher participation of younger cohorts of women in tertiary education. However, because they start from such a low level, policy action is probably desirable.

36. About 72% of them are foreign nationals who come to Switzerland for the purpose of studying. The other 28% are persons who are living in Switzerland with a foreign nationality. The proportion of foreign students is higher in general universities (16.3%) than in UAS (9.4%).

37. In 2003, 1.8 million adults took 121 million hours of training, which is roughly average, even though 36% of the population receives continuing training (Office Fédéral de la Statistique, 2004).

countries, people with higher educational attainment invest more in continuing education. This is one area of education where the Swiss government spends less than other countries, and lifelong learning is mostly left to private initiative. The lack of harmonised and recognised certification also makes it difficult to gain from the training received.Lastly, many workers report the unavailability of time as an obstacle to pursuing continuing education.

Are framework conditions and policies adequate?

This section reviews framework factors and policies that influence innovation and more generally entrepreneurship. The impact of framework conditions and policies on innovation is at least as large as that of innovation-specific policies (Jaumotte and Pain, 2005d). Entrepreneurship includes innovation but is broader. It includes the creation of new firms and the growth of existing firms, both of which are important for innovation. The creation of new firms is a channel through which innovations are brought to the market, while the growth of existing firms increases the impact of their innovations on the economy and reinforces their innovative capability.

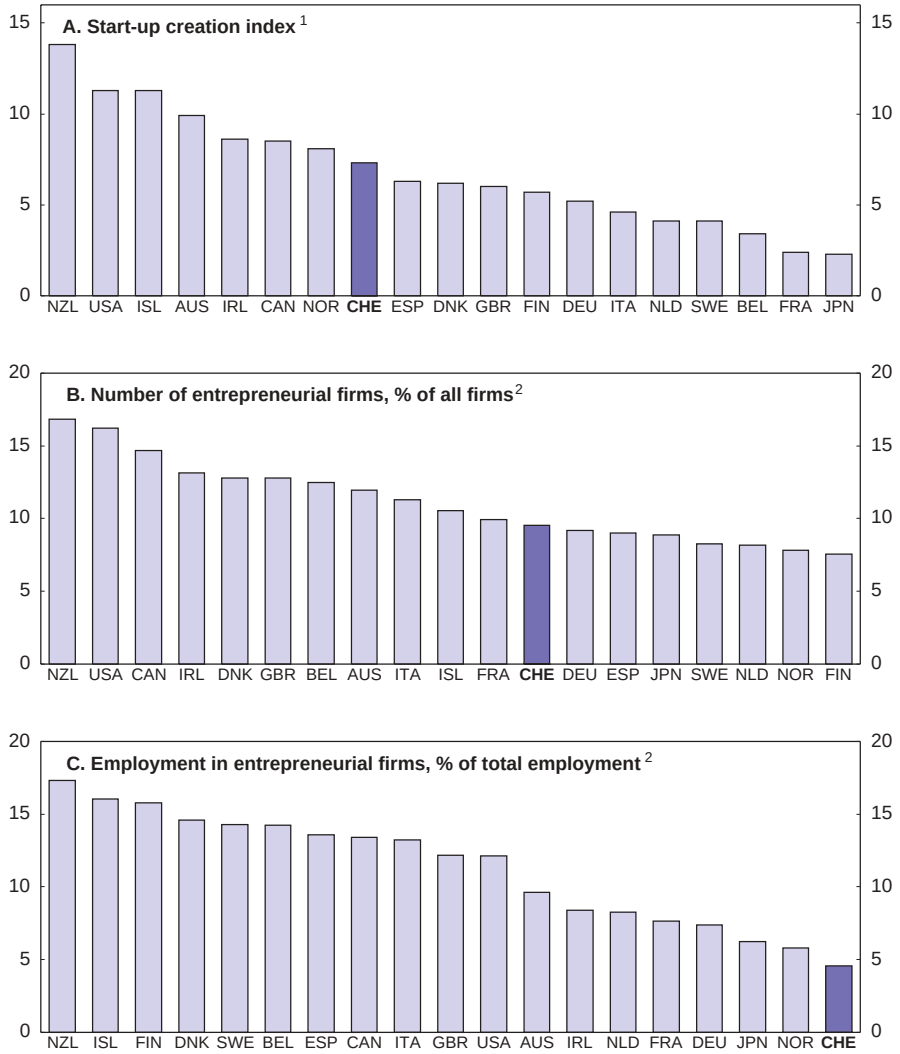
Switzerland ranks in the middle of international comparisons of firm creation, though it performs well relative to most other European countries. But it ranks very low on the entrepreneurial activity of existing firms, defined as the combination of innovativeness and job growth (Figure 16).[38] The much worse performance on entrepreneurial activity than on innovation survey indicators reflects the additional criterion of job growth. The lack of growth of firms in general and of innovative firms in particular is a problem. Entrepreneurial firms account for a very small fraction of employment, reducing their impact on the economy. In Sweden and Finland, entrepreneurial firms account for a much larger share of total employment, though it is concentrated in a few large firms. The low entrepreneurial activity of existing firms is also likely to reflect the inclusion in the Global Entrepreneurship Monitor (GEM) survey of very small firms and sheltered services sectors with low productivity growth in Switzerland.[39]

The topics reviewed in this section include competition and trade policies, administrative burdens on start-ups, socio-cultural norms, the legal system and financial sector policies. The impact of the weak trend growth and low participation in tertiary education has already been discussed above and is not further examined here. It should be noted however that apart from the weak trend growth, macroeconomic conditions are relatively favourable to innovation in Switzerland. The economy is very stable, with low inflation and real interest rates, and relatively sound public finances (OECD, 2006a).

38. This is according to a recent survey by the Global Entrepreneurship Monitor (GEM), the most renowned panel survey of entrepreneurship worldwide. This project was launched in 1999, and Switzerland was included for the first time in 2002. Recent articles using this dataset include Audretsch *et al*. (2005), Drnovsek and Erikson (2005), Wong Ho and Autio (2005) and Bygrave (2003). For Switzerland, the survey involved phone interviews with a representative sample of 2 000 adults and face-to-face interviews with 36 experts. Switzerland performs significantly below the average for the countries included in the GEM survey on the indicator which combines the share of entrepreneurial firms and the share of employment in entrepreneurial firms.

39. This is true for all countries since the share of entrepreneurial firms is quite low for all countries relative to the high proportion of innovators reported in the innovation surveys. Yet, Switzerland's relative position is significantly worse in the GEM survey.

Figure 16. **Global scope of entrepreneurial activity**
2003



1. This refers to the percentage of adults aged 18-64 years who are either in the process of creating a new firm or the owner-manager of a new firm. It corresponds to the "total entrepreneurial activity index" from the Global Entrepreneurship Monitor survey.
2. An existing firm is considered as entrepreneurial if it had at least a small amount of job growth and any modest impact in terms of providing new goods or services in the market place.

Source: Global Entrepreneurship Monitor, *2003 Executive Report*.

Increasing competition and trade openness is key to raise innovation incentives

Competitive pressures remain very low in Switzerland, due to stringent product market regulation and limited integration with the European Union (OECD, 2006a). Cross-country studies show large stimulating effects of raising competition on the innovation performance of the business sector (Jaumotte and Pain, 2005b and d) and entrepreneurship more generally, especially when the economy starts from a

low level of competition.[40] Raising competition is thus the policy reform that should have the largest impact on the innovativeness of the Swiss economy, especially in sheltered sectors and small firms.

Another related problem is the small market size. The obstacles to trade with the European Union, due to administrative and technical regulations, increase the difficulty and cost of entering new markets. The proposed unilateral adoption of the Cassis de Dijon principle (*i.e.* the adoption of EU standards and – in the event of non harmonised EU-standards – the acceptance of product standards of selected foreign countries) will go a long way towards increasing domestic competitive pressures. It will be important to negotiate the same access for Swiss products on the EU markets and – where such harmonisation and mutual recognition have not occurred – to allow Swiss producers to serve the domestic market with products designed for export in EU countries. In some sectors, the small market size problem is exacerbated by the fragmentation of the domestic market which prevents firms from reaching the critical size and experience. In this respect, the proposed revision of the Domestic Market Act, which aims at further unifying the domestic market, will help. A stronger integration of the domestic market and with the EU market could have a large impact on the growth potential of domestic firms.

Finally, innovation policies can also have undesirable effects on competition and further innovation, especially when intellectual property rights (IPR) are too generous. There is a risk that patents are used to restrict competition and block subsequent innovation, particularly in the fields of biotechnology and ICT where innovation is cumulative.[41] A recent survey of biotech researchers (Thumm, 2003) concluded that this is not generally a problem in Switzerland, though moderate problems were found for some DNA patents and patents on methods for genetic testing. Solutions could include limiting the scope of patent protection to specific disclosed functions, introducing broad research and/or clinical exemptions, and compulsory licensing. However, the pressure to grant strong IPR to biotech inventions, as is currently the case in the United States, is also very high in Switzerland, because of the high potential of the biotech industry and the signalling effect for future legislation at the EU level.

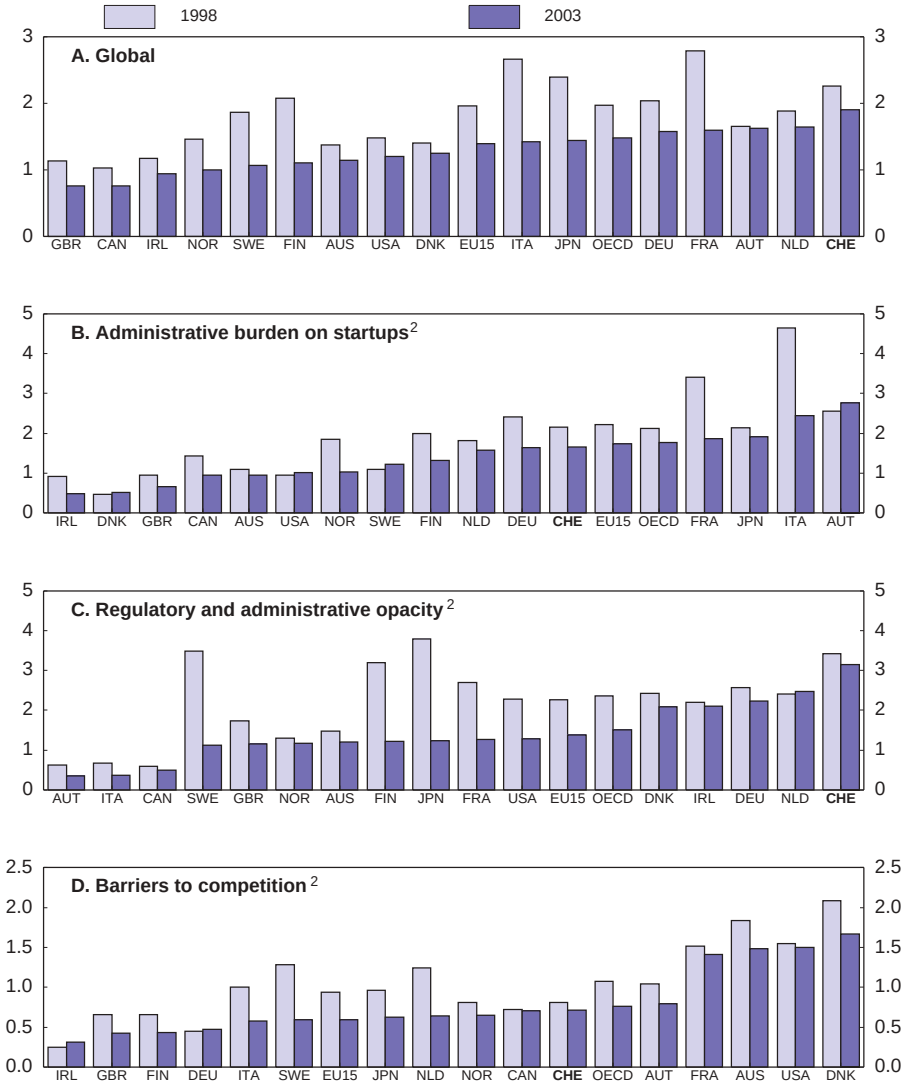
There is much scope to reduce administrative burdens

Administrative burdens remain relatively high in Switzerland (Figure 17) and official estimates put their cost at some 2% of GDP (Müller, 1998). Switzerland performs better than the EU average on the number of procedures and days needed to set up a business. But there remain significant hurdles related to tax declarations (in particular VAT), withholding for basic old age insurance and authorisation procedures

40. The relationship between competition and innovation is often thought to be hump-shaped (Aghion *et al*., 2002). Much depends on the size of the difference between pre-innovation profits and ex-post profits. When competition rises from a low level, incumbents have incentives to innovate to escape from competition and potential entrants have incentives to innovate to catch-up or surpass the technologies of incumbent firms. However, when competition is very strong, the expected gain from innovating may be too small to give sufficient incentives to innovate. In this case, the much lower level of profits may also reduce the capacity of firms to finance their innovation projects. As Switzerland is starting from a relatively low level of competition, there is little cause for concern that additional competition could reduce innovation.

41. Patents can block further research when they relate to research tools or when their coverage is too broad (including for example all possible applications or surrounding fields). Moreover, the high transaction costs to coordinate all right holders in order to get the necessary licenses may act as a barrier to entry. Cross-licensing arrangements and "patent pools" are common in such industries and potential entrants, which do not have patents to exchange, may not be able to join. Some evidence was found in Jaumotte and Pain (2005b and d) that excessively strong IPR may reduce the efficiency of research.

Figure 17. **Barriers to entrepreneurship**[1]



1. The indicators range from 0 (least restrictive) to 6 (most restrictive).

Source: OECD, Product Market Regulation database.

(OECD, 2006d). A project is under discussion to simplify the VAT system and reduce the number of rates.[42] It is more difficult to simplify the social insurance system due to the high degree of decentralisation, though a greater use of ICT could help reduce the administrative burden.[43] With respect to authorisation procedures, which account for one quarter of the administrative burden, the government's initiative to eliminate little used procedures and simplify frequently asked authorisations goes in the right direction. The government should also consider the adoption of the principle whereby "silence means consent". This principle implies that if the administration does not give an answer by a fixed deadline the

42. The minimum turnover required to obtain a VAT number also remains too high (CHF 100 000).

43. An additional problem is the difficulty for individual entrepreneurs to use their right not to contribute to the second pillar of the pension system, due to abuse by subcontractors.

authorisation is considered as granted. This principle, used in several OECD countries, would shift the burden from businesses to the administrations and give the latter an incentive to raise their efficiency.[44]

Federalism also hampers the creation of one-stop shops for setting up businesses and the development of e-government. Switzerland is not well placed in terms of e-government (OECD, 2006a). However, matters are starting to improve: it is now possible to create a firm on-line, and this facility should soon be expanded to include not only announcement to, but full registration for VAT and social security, and it should cover all types of companies. Nevertheless, much more could be done. The variation of laws and regulations across cantons has also created a strong regulatory and administrative opacity (Figure 17). In 2003, only one OECD country had a stronger opacity than Switzerland. This affects the cost of setting up a business and of expanding activities to other cantons and reduces effective competition, including for public procurement. Administrative burdens are especially heavy in the construction sector, as well as in social security and tax administration.

Finally, instruments have been created to better take into account the viewpoint of SMEs in the elaboration of new laws and regulations. These include regulatory impact analyses (RIA), SME compatibility tests, which survey the difficulties encountered by SMEs in the execution of regulatory acts, and an SME forum, which presents the viewpoint of SMEs in the political decision process. However, these have had little impact so far on the elaboration of laws and regulations, due to a lack of resources which means that the SME viewpoint is not brought to the attention of decision-makers.

Socio-cultural norms and the legal system need to promote risk-taking

There is also room to further promote creativity and entrepreneurship. The opportunity costs of entrepreneurship are high because the labour market offers well paid jobs. And primary and secondary schools do not promote entrepreneurial attitudes well. Firm owners are also more focused on retaining control of their businesses than expanding their activities and are therefore reluctant to let investors in and/or sell the firm.

The legal system, in particular the bankruptcy law, reinforces risk aversion. There is no time limit to sue a bankrupt entrepreneur if he was the owner of a private company or if he owned a limited or public company and used his own wealth as collateral for bank or other private credits made to the company (Balastèr and Senn, 2004). The latter is quite common in the case of start-ups. In other OECD countries, the right to sue a bankrupt entrepreneur expires after 1 to 12 years, depending on the country. The effects on entrepreneurship are potentially important. The high penalty for bankruptcy discourages in relevant cases potential and actual entrepreneurs from setting up their own business or a new business. Entrepreneurs are also less likely to take risks and may refrain from expanding their activities, in particular if it would require using bank credits.

However, an expert commission advised against the rebalancing of interests in favour of debtors, on the grounds that fraudulent creations of limited and public companies are common. A proposal is currently being examined to grant a more generous access to the procedure of "concordat", which allows firms with payment difficulties to settle financial problems with creditors while pursuing their business. Switzerland, on the other hand, ranks well with regard to the time required for the implementation of a bankruptcy procedure. World Bank indicators point however to a low recovery rate of the bankruptcy procedures and high costs for liquidation.

44. See OECD (2004c) for a more detailed discussion of this principle.

The role of venture capital and equity financing should be strengthened

Finding financing is one of the main hurdles for business founders. Despite the very large capitalisation on the Swiss stock market, equity financing and venture capital play a very modest role in the financing of new businesses and risky innovation projects.[45] The main sources of funding for new businesses are family and bank financing. Innovative projects are mostly financed out of internal funds and to a lesser extent bank loans. Though the will to retain control of one's own business may partly account for this, there are a number of tax and legal issues which limit the use of equity financing for risky firms and projects.

Equity financing

The double taxation of dividends makes equity financing expensive compared to internal funds and bank loans, especially for young expanding firms which do not have access to international capital markets.[46] Switzerland is one of the last OECD countries to not apply relief from the double taxation of dividends (EconomieSuisse, 2005; van den Noord, 2005) and the distortion is important, despite favourable corporate tax rates and zero taxation on capital gains of individuals. The authorities are currently planning to alleviate it by taxing only 60% to 80% of dividends (OECD, 2006a), but this will not be sufficient to reduce distortions significantly. Together with the bankruptcy law, which makes entrepreneurs reluctant to borrow extensively, the high cost of equity financing slows the growth of small and new firms, which have limited internal funds. The double taxation also hampers the reallocation of funds across firms, by encouraging the reinvestment of profits within the own company, and this shows up in a very low efficiency in the use of capital (OECD, 2006a). Finally, it discourages the investment in venture capital, a potentially important source of financing for young and small innovative firms.[47]

Venture capital

The Swiss venture capital market is small in international comparison, even relative to most of its European neighbours (Figure 18). And it is more used by older firms and for low-risk projects than younger and innovative firms. The supply of venture capital may be somewhat underestimated, as it does not include informal venture capital from cantonal and regional banks[48] and from big pharmaceutical companies to biotech firms. Yet, most of these factors are also at play in other countries and are unlikely to change the picture significantly. As in most countries, the bursting of the internet bubble and the stock market fall in 2001-02 dried up the supply of venture capital, but the market has now started to pick up again.

Despite its small size, the Swiss venture capital market is quite internationalised, with both large cross-border outflows and inflows relative to domestic investments. The net inflow has recently become

45. Venture capital is usually considered as an important source of financing for innovative firms, in particular start-ups and small firms. Venture capitalists have high sector-specific expertise which enables them to better overcome the problems of asymmetric information in the assessment of innovative projects. They also play an important function by providing management and coaching services to the entrepreneur. The provision of such services often requires local knowledge, limiting the role that cross-border investment can play in early-stage development. On the other hand, balancing risks pleads in favour of global portfolios.

46. Profits are first taxed at the corporate level and then as dividends if they are distributed.

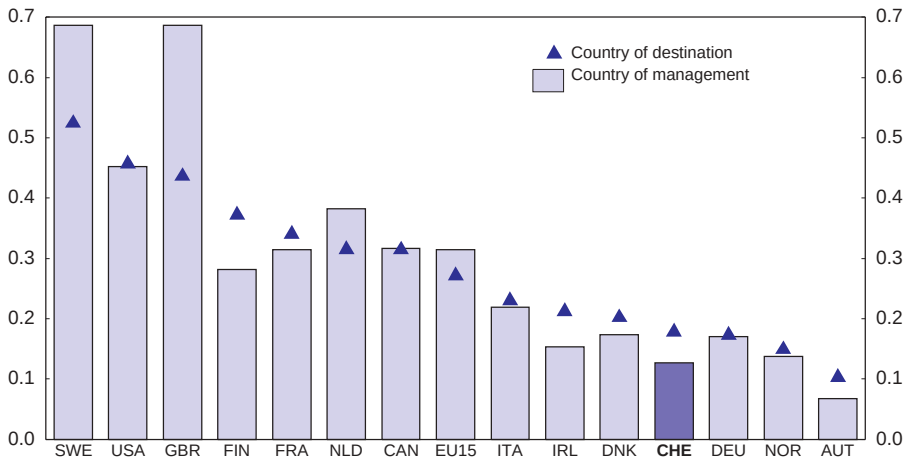
47. It also creates difficulties for management buy-outs and inheritances (when one of the heirs wants to get out of the company).

48. Due to strong local loyalties, some cantonal and regional banks provide venture capital and even seed capital to their clients.

slightly positive, which may suggest that investment opportunities are improving. However, the desire of entrepreneurs to retain the control of their firm and the reluctance to expand activities generally limit investment opportunities and raise transactions costs.[49] Improving the conditions for technology transfers from universities to firms would also contribute to broadening investment opportunities.

In addition to demand constraints, there remain a number of legal obstacles to the development of the supply of domestic venture capital, despite significant improvements in recent years. In 2000, the government introduced a law reducing the double (sometimes triple) taxation of venture capitalists when a minimum of 50% of the funds are invested in new Swiss firms.[50] These tax incentives have proven insufficient to induce major changes. Many venture capitalists choose to operate off-shore where they can establish as limited partnerships, a tax-transparent company structure.[51] A similar company structure should be introduced in Switzerland as part of the new law on investment funds. There is also room to further relax the conditions under which pension funds (from the second pillar) can invest in venture capital. Venture capital funding by pension funds is limited by the obligation for pension funds to obtain a minimum annual return. Given the long-term nature of pension obligations, the minimum guaranteed return could be redefined on a pluri-annual basis. Pension funds accounted for only about 10% of venture capital in 2002, a much lower share than in many other countries.

Figure 18. **Venture capital investment**
As a percentage of GDP, 2000-03



Source: OECD, based on data from EVCA (Europe); NVCA (United States); CVCA (Canada).

49. This does not apply to the biotechnology sector however, where it is a rational strategy to remain small in order to be bought back by a big pharmaceutical company.

50. The minimum participation needed in the capital of a company to benefit from an exemption of taxes on capital gains and dividends was reduced from 20% to 5% (or CHF 250 000 instead of CHF 2 million). Business angels can deduct from their taxable income 50% of the subordinated loans they make to new independent Swiss companies, up to a limit of CHF 500 000. If the loan is reimbursed, the tax has to be paid, otherwise an additional amount can be deducted from income.

51. A company structure is deemed tax transparent if it is not taxed itself.

The framework conditions for start-up financing also need to be further improved. The reduction in 2001 of the minimum nominal value of shares from CHF 10 to one cent was a welcome step. It also facilitates initial public offerings by increasing the number of available shares. One remaining impediment to start-up financing is the taxation of stock options at grant instead of at exercise. Start-up firms often distribute stock options to their employees to compensate them for the fact that they can only afford to pay relatively low salaries. Although in theory taxation at grant should be equivalent to taxation at exercise if it is based on fair market value of the options (OECD, 2005b), it is often perceived as penalising, including in Switzerland. This perception may be well founded in some cases because the payment of the tax comes precisely at the time when employees have low salaries and may be subject to liquidity constraints.[52] Moreover, the high risk that the firm goes bankrupt may not be fully incorporated in the fair market value for individuals with above-average risk aversion. For example, in the United States where stock options are very common, taxation is either at exercise or at disposal of the shares. The Swiss government intends to change the tax treatment of the options and to introduce a reduced taxation of options at the time they are exercised.

Finally, a simplified access of high-growth companies to the stock market is essential to provide venture capitalists with an efficient way of exiting companies and recuperating their initial investment. As in other European countries, the financial market problems at the turn of the century led to closing the recently launched segment for high-growth companies ("SWX New Market") and to integrate it in the principal stock market. From an operational point of view, its integration in the Swiss Exchange may not have changed much. However, it is important to improve further this exit channel for venture capitalists; the potential in this area may depend to a large extent on the future development of the Swiss and European stock markets.

Internal funds

The availability of internal funds in small and new companies could be increased by expanding provisions for the carry-forward of losses. They are currently limited to seven years, while many OECD countries allow indefinite carry forward and some countries even allow the carry back of losses to previous years.

Conclusions

Due to very high labour costs, Switzerland needs to maintain a top position in innovation performance to preserve its competitiveness and living standard. On balance, its innovation performance has been amongst the best. Among others, the country occupies a top position in knowledge-intensive market services which attract many people trained in science and engineering and related to this it is also a heavy user of ICT. However, innovation performance has weakened somewhat in recent years. The weakening resulted to some extent from the protracted economic slowdown, but there are areas in which policy reform could further strengthen Switzerland's innovation capacity (Box 4).

Much could be gained from a strengthening of framework conditions for entrepreneurship. The focus of the growth package on raising competition is well placed, as this is likely to be the most stimulating policy reform for innovativeness and entrepreneurship, especially in small firms in sheltered sectors. Such a reform may also be expected to encourage the growth of firms, which remain very small, by facilitating their access to a larger unified domestic market and eliminating rents. In this respect, deep integration with the EU market should be pursued, for example by negotiating an elimination of

52. Note however that for countries that allow companies to deduct the cost of stock options, the deduction is usually allowed at the same time as the employee is taxed. Thus, taxing the employee earlier gives the company a deduction earlier, thereby easing its liquidity problems.

administrative and technical barriers to entry of Swiss products. Administrative burdens are a second important obstacle to entrepreneurship, especially due to the lack of co-operation among cantons. The government's initiative to simplify administration goes in the right direction. But more should be done to modernise public administration by increasing the use of information and communication technology. A third obstacle to entrepreneurship is the bankruptcy law which in situations relevant for new undertakings extends de facto creditors' claims against a bankrupt entrepreneur indefinitely. Beyond its deterrent effect on the creation of businesses, entrepreneurs are less likely to take risks and may refrain from expanding their activities, in particular if it would require using bank credits. There is therefore a need to reform the bankruptcy law. Finally, equity financing and venture capital still play only minor roles in the financing of new ventures and innovation projects. Although this could reflect low demand, as entrepreneurs want to retain control of their business and refrain from risk-taking, there is room to improve framework conditions for such modes of financing. Current proposals to reduce the double taxation of dividends, and hence the cost of equity financing, could be more ambitious. The government's plan to introduce a tax-transparent company structure for venture capitalists goes in the right direction, while restrictions on pension fund investments in venture capital should be relaxed and initial public offerings facilitated.

The growing knowledge economy increases pressures to upgrade and lengthen education, traditionally focused on vocational training. The quite low participation in tertiary education results in a limited domestic supply of scientists and engineers. This is compensated to some extent by large inflows of foreign scientists and engineers and substantial R&D activity in other countries. However, if Switzerland is to keep its position in the global value chain, there is a need to expand tertiary education, especially at university level. Significant efforts have already been made by upgrading vocational education at the secondary school level and creating universities of applied sciences which made it possible to conclude vocational education at university level. This strategy should be pursued by further strengthening vocational curricula and continued reform within and among universities of applied science. The authorities are currently preparing a reform of the whole university system, which will improve the quality and efficiency of university education – by reducing, for example, the time required to complete studies. Key elements include a consolidation and specialisation of the very fragmented university landscape, the introduction of a standard cost-related education subsidy per student in each field, and the development of quality assessments. While this reform faces resistance from universities, which may have to undergo restructuring, it is necessary nonetheless. The implementation of the Bologna process, which aligns the structure of studies with other European universities, will also put increased pressure on Swiss universities to raise the attractiveness of their studies to both Swiss and foreign students. Raising tuition fees for tertiary education should be studied, though the latter should be accompanied by a loan system with income-contingent repayments. In addition to increasing the available resources, tuition fees would also contribute to induce quality enhancements in the university system through pressures from students' choices. Another Swiss specificity is the under-representation of women in tertiary education, especially in sciences and engineering. The incentives facing women to undertake tertiary education may be reduced by limited career prospects; adopting more favourable family-work reconciliation policies could help in this respect. However, specific efforts may also be needed to stimulate women's interest in sciences and engineering from an early age, since the share of women in these fields is extremely low in international comparison. Finally, more policy attention should be devoted to lifelong learning, which is key in a knowledge society. Measures such as promoting the recognition of qualifications, creating a time entitlement to adult education and training and providing some financial support would raise participation in such human capital development.

Overall, innovation-specific policies seem adequate, though there is some room for consolidation and improvement. Switzerland stands out in not providing direct financial support for business R&D. This seems appropriate, given the already very high level of business R&D and hence the risk of large deadweight losses. The country also has a very strong basic research capacity, which is only partly funded by the public sector. One main source of concern is the availability of sufficient public resources for

research and the difficulty in fulfilling spending priorities on education and research in recent budgets, due to fiscal consolidation and mandatory increases in social spending. Public funding is important to sustain basic research, which is widely available, and to support the transfer of technology between academics and businesses. To preserve the world-class research and education outputs of several tertiary education institutions in Switzerland, national public funding for research must be given a high priority. Enhanced co-operation at the international level should not endanger national research funding. Beyond this, there is a need to better bridge the gap between fundamental research and the market. This should be achieved through boosting the funding of R&D at public research institutions by substantially increasing the resources of the Commission for Technology and Innovation (CTI). CTI finances R&D for the business sector at Swiss public research organisations according to a public-private partnership model for innovation in products and services. The commission's bottom-up approach to strengthen technology transfers between academics and firms, its coaching services for start-ups as well as its nation-wide education programme for would-be entrepreneurs, go in the right direction.

Box 4. **Recommendations concerning innovation policy**

Improve framework conditions for entrepreneurship

- Pursue efforts to increase competition and reduce market segmentation, by revising the domestic market law, eliminating administrative and technical barriers to EU imports (Cassis de Dijon principle) and negotiating the same access for Swiss products to the EU markets.
- Reduce administrative burdens, including by streamlining authorisation procedures, introducing the principle whereby "silence means consent", and developing e-government.
- Reform the bankruptcy law to reduce the prescription period and facilitate the use of the procedure of "concordat".
- Further reduce the double taxation of dividends to levels comparable in other countries; expand provisions for the carry forward of losses.
- Improve the institutional and legal framework for venture capital by introducing a tax-transparent company structure, by taxing options at exercising instead of granting and by redefining the minimum guaranteed return on pension funds on a pluri-annual basis.

Consolidate innovation-specific policies

- Give public funding for research a high priority.
- Intensify co-operation in international research without endangering national research funding.
- Increase private funding of university research, by expanding the activities of the offices of technology transfer and facilitating the direct business funding of university research.
- Stimulate applied research by increasing the resources of the Commission for Technology (CTI) and Innovation to better bridge the gap between fundamental research and the market.
- Increase coaching services for entrepreneurs and formal business training for scientists and engineers.
- Pursue the consolidation of the offices of technology transfers across universities and further develop their activities.
- Limit the scope of patent protection for DNA patents to the specific disclosed functions and introduce a broad research exemption concerning biotechnology-related inventions.

Strengthen higher education

- Further reinforce vocational curricula.
- Pursue the reform of the whole university system, including the specialisation and profile building of universities, the introduction of a standard education subsidy per student and the development of quality assessments of universities.
- Consider a rise in tuition fees while developing a system of loans with income-contingent repayments.
- Increase women's interest in sciences and engineering from an early age, for instance through the organisation of science days and fairs and mentoring; strengthen work-family reconciliation policies.
- Provide students from non-EU countries graduating in Switzerland more time to find a job in Switzerland.
- Expand lifelong learning, by improving the certification of training, by introducing a time entitlement and by eventually raising public funding.

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